ALBERTA VEGETABLE PRODUCTION GUIDE

1989 - 1990

For Commercial Growers

Alberta
AGRICULTURE
AGDEX 250/13-1

89-03423/

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Medical attention must be obtained as quickly as possible.

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ALBERTA VEGETABLE PRODUCTION GUIDE 1989-1990

This publication is for use by commercial producers and the pesticides recommended are often only available to commercial growers. Home gardeners should use chemical recommendations as given in home garden publications listed in the back of this publications.

This guide is divided into six general sections:

1. General Crop Production Management and Marketing
2. Bedding Plant Plug Production
3. Pest Management
4. Soil Management and Fertility
5. Irrigation Management
6. Vegetable Production Recommendations
7. Appendix

Subjects under each section are in the list of contents

Specific variety, pesticide and fertilizer recommendations are included under the production recommendations for each crop. (Section 6)

The amounts of material listed in the recommendations are for one acre , unless otherwise stated. AMOUNTS OF CHEMICALS ARE GIVEN IN AMOUNT OF ACTUAL PRODUCT TO BE USED unless otherwise noted.

A number of brand or trade names are used for the convenience of readers. This constitutes neither an endorsement of the product nor a suggestion that similar products are not effective or available.

It is impossible to cover all situations in such a publications. Growers who wish more information on any areas related to vegetable production are invited to contact the appropriate personnel listed on the back cover of this guide.

WARNING

All pesticide products that are recommended in this guide are registered by Agriculture Canada. No pesticide may be used on any crop for which it is not registered. Use of unregistered chemicals can result in seizure of the crop.

The pesticides recommended in this guide were registered at the time of writing but pesticide registrations may change. Growers are responsible for applying only registered chemicals using the correct rates and procedures. Always follow manufacturer's recommendations on the label.

The pesticides are listed in this book as a guide to producers and these recommendations have no official sanction.

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SECTION 1
CROP PRODUCTION MANAGEMENT AND MARKETING

This section of the guide covers major topics as they relate to production and marketing of fresh vegetables in Alberta. Current practices are discussed along with developments that may have a major impact on the industry.

SEED BED PREPARATION AND SEED GERMINATION

Soil Preparation

A good seed bed must be level with uniform compaction and evenly distributed moisture. The best way to obtain this homogeneity is to postpone preparing the soil until it has dried out enough so that it can be treated uniformly, even in the wettest areas. If the soil is full of clods or wet in patches, it is inadvisable to seed because of any possibility of obtaining good germination results can be ruled out before-hand.

Proper depth of cultivation is important for optimum germination. A common problem overlooked is poor seed/soil contact. A light, fluffy seed bed may look nice, however, the consequence of poor seed contact with soil is poor germination. Several growers have mounted a packer roller in front of the seeder that spans the full width of the seed bed. The small packer wheels on the seeder unit generally do not provide adequate soil compaction.

Soil Temperature

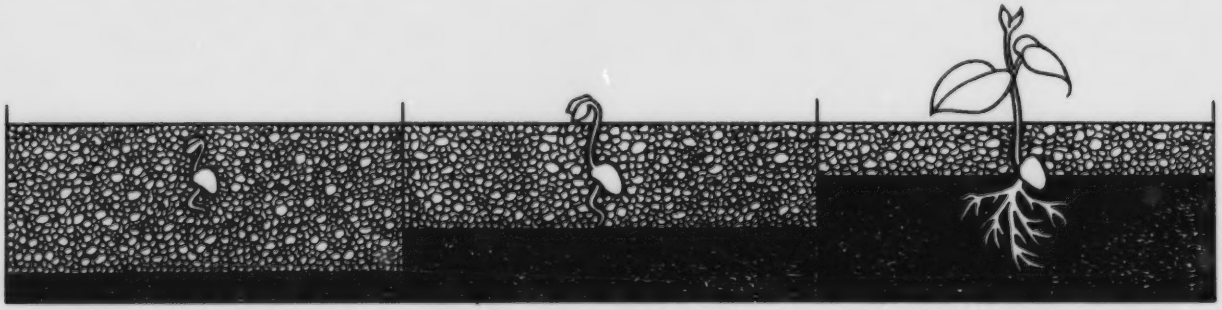
The process of germination also depends on the temperature of the soil. The longer soil temperature remains below the optimum level, the longer germination will be delayed. Also, when the soil is too cold to permit germination, seed rot organisms combined with soil compaction that generates crusts may hinder seedling emergence.

Crop	Optimum Field Soil Temperature for Germination, °C
Beans	15-30
Beets	10-30
Cole Crops	7-30
Vine Crops	15-35
Carrots, Parsnip	7-30
Onions	10-35
Peas	4-24
Rutabaga	15-38

Soil Moisture

When sold, seeds have normally been dried to a water content of only 5-6%. Before they can germinate, seeds need to absorb so much moisture that their water content rises to 45-60%. If possible, seeding should not take place until the soil moisture capillary action has had time to re-establish itself, about 5-8 days after preparation of the seed bed.

Irrigation is critical to seed germination. Nozzels that emit fine water droplets are recommended. Frequency of irrigation is an important factor and can prove to be difficult if dry, windy conditions persist and if an irrigation system is over extended. Experience with several growers in southern Alberta has shown the pivot to be superior because of its capability to apply light applications of water frequently. A 1 cm (¼ in.) application every day is feasible with this system. With a sideroll system, per line of lateral pipe a maximum area of 20 acres is recommended. Pipe should be moved every 4 hours so that 1 to 2 cm (3/4 in.) of water is applied every



Cultivated too deep: The moisture supply is retared from the untouched soil beneath.

The seeds will have difficulty sprouting because they lie on a loose soil layer and cannot absorb enough water to germinate properly.

Not cultivated too deep, gives better supply of moisture from the untouched soil beneath.

other day. A handmove system is more flexible, and if not solid set, it should be handled like the sideroll.

The key to successful seed germination is to keep the top 1 cm (½ in) of soil moist. Too often neglect at this early stage of production jeopardizes yield and quality of the entire crop.

A final note on seed and moisture relates to coated seed. The general feeling among growers in Alberta who have tried coated seed is that it requires more moisture and time to germinate than does raw seed. This has generally been shown to be the case in the United States also. The difficulty of coated seed germination is greatly heightened under a sideroll irrigation system if wide fluctuations in soil moisture occur during germination.

Soil Crusting

Seedling emergence is affected by the additional factor of soil crusting. It is the most visible obstacle to emergence.

Soil conditioning is a general term used for treating emergence problems. The most important single cause of poor emergence, including crusting, is the tendency of soil particles to stick together. This occurs in all types of soil and in both wet and dry conditions. The size of soil particles is a primary influence. As the diameter of soil particles get smaller, particles stick together more, density increases, aeration decreases and other adverse effectsmultiply.

Typically, cohesion (particles sticking together) increases with time after cultivation. Getting a good stand, therefore, becomes a race between the process of germination and emergence and the development of a soil crust. Both seed germination and soil crusting are affected by the same three factors of moisture, aeration and temperature.

Of several chemical anti-crustant products tested in Alberta, none have been found to work well. Soil chemistry, the way a conditioner is applied and environmental conditions affect performance. Here in Alberta, low relative humidity hinders anti-crustant activity. All chemical anti-crustant products require lots of moisture to be activated and unless the soil surface is kept moist continually, anticrustant products fail to function properly.

Functional solutions to soil crusting problems used in Alberta and elsewhere include plug-mix planting and fluid drilling. Some research work in the United States is looking at anti-crustants sprayed on the soil surface and banding in a narrow band over the seed line. The major problems with these developments are limited by the engineering of the equipment that will apply products in uniform bands over the seed row.

Establishing a Desired Plant Stand

Precision Seeding

Precision seeders have been in use in Alberta for many years. The versatility of the precision drill has enabled growers to make full use of the concept on practically all crops. Precise placement of the seed in the row improves quality of the product by enabling uniformly spaced plants to develop at the same rate. The production of root crops such as carrots and onions has benefited the most from precision seeding. The result has been that less effort is needed in grading and packing and fewer culls are obtained. A further benefit of precision drilling is that less seed is required and thinning may be reduce or eliminated.

To achieve complete success with precision seeding, factors such as seed sizing, seed coating, high germination, good seedbed preparation and uniform seeding depth must be used. By omitting one or more factors, the results of precision seeding may be no better than with more conventional seeding methods.

The most common type of precision seeder used in Alberta is the Stanhay belt seeder. It is a versatile seeder that can be used to seed most vegetable crops using either a rubber or plastic belt. It offers the advantage of being able to seed crops like carrots in wide 7.5-10.0 cm (3-4 in.) bands as opposed to narrow single rows. Often more crop can be grown and harvested per unit of row when seeds are planted in a wide band.

Crops that are well suited to precision seeding with the Stanhay seeder and the type of belt required for each if raw seed is used are:

Asparagus (rubber, single rib)	Cucumbers (rubber, smooth)
Beets (rubber, triple rib)	Lettuce (plastic)
Broccoli (rubber, smooth)	Onion (rubber, smooth)
Cabbage (rubber, smooth)	Parsnip (rubber, smooth)
Carrots (plastic)	Rutabaga (rubber,smooth)
Cauliflower (rubber, smooth)	Sweet Corn (rubber, single rib)

Through years of research into precision seeding, ideal row configuration for vegetable crops can vary based on the market intentions of the crop. Row configuration refers to the number of rows with holes to accommodate seed on each seed belt. Such

flexibility with a precision seeder allows a grower to delay or enhance crop maturity and also influence head or root size. With the Stanhay belt seeder, the following is generally recommended:

Asparagus (single line)	Cucumbers (single line)
Beets (twin line)	Lettuce (single line)
Broccoli (single line)	Onion (twin line)
Cabbage (single line)	Parsnip (single line)
Carrots (twin or triple)	Rutabaga (single line)
Cauliflower (single line)	Sweet Corn (single line)

The distance between seed drop from each line varies from 1 to 7 cm (¼ to 3¼ in) depending on the type of coulter used.

The topic of precision seeding is complex and further details are available by contacting one of the vegetable specialists listed on the back cover of this publication.

Graded or Sized Seed

When using non-pelleted or raw seed, it is essential that the seed be graded by size. Some suppliers can provide graded seed; however, grading

Table 1

Seed and Spacing Requirements for Vegetable Crops

Vegetable	Approx.* seeds per ounce	Seed Required: For 100 ft row seeded direct (oz)	Seed Required: per acre: Trans-planted	Seed Required: per acre: Seeded direct (lb)	Desired final plant spacing: Apart in row (in)	Desired final plant spacing: Between rows (in)	Depth of planting (in)
Asparagus	700-1500	1	2 lb	6	12	36-48	1-1½" in furrows
Bean Bush	60-100	1 lb	-	45-80	1-2	24-36	1½-2
Beet	1600	1	-	10-16	1-2	12-24	½-1
Broccoli	9000	¼	4 oz	½-2	12-18	18-30	½-3/4
Brussels Sprouts	8-9000	¼	4 oz	-	18-24	18-36	-
Cabbage	8-9000	¼	4 oz	½-2	16-20	24-36	½
Carrot	12-25000	¼	-	3-5	1	18-24	½
Cauliflower	8-9000	¼	4 oz	½-2	12-18	24-36	½
Celery	50-70000	¼	4-8 oz	-	6-8	18-36	-
Corn, Sweet	100-200	½ lb	-	10-15	6-14	22-36	1-2
Cucumber	1000	¼	1-2 lb	3-5	3-6	4-6 ft	1-2
Eggplant	6000	1/8	4 oz	-	18-24	24-36	-
Lettuce	20-25000	¼	8 oz	1-2	8-14	12-24	½
Onion	8-9500	1	-	3-4	2-4	12-24	½-1
Parsnip	6-12000	¼	-	3	1-3	18-24	½-1½
Peas	100-250	1 lb	-	50-300	1-3	6-24	1-2
Pepper	4-4500	1/8	4 oz	-	12-18	18-30	-
Pumpkin	100	¼	1-2 lb	3-4	3-4 ft	8-12 ft	1-2
Radish	2-3500	1	-	10-15	1	8-12	½-1½
Rutabaga	8-12000	¼	-	½-2	4-6	24	½-1
Spinach	2800	1	-	15	2-4	12-18	½-1
Squash	100-300	¼	1-2 lb	1-3	3-4 ft	3-8 ft	1-2
Tomato	10-11000	1/8	2 oz	-	18-24	24-36	-

*may vary considerably.

Table 2

Row-feet Per Acre and Number of Plants Per Acre at Various Plant Spacings

Distance between rows (in)	Row-feet per acre	Distance between plants within the row (inches)								
		1	2	4	6	12	18	24	30	36
		Number of plants per acre								
12	43,500	525,000	260,000	130,680	87,120	43,560	29,040	21,780	17,420	14,520
18	29,000	350,000	175,000	87,120	58,080	29,040	19,360	14,520	11,620	9,680
24	22,000	260,000	130,000	65,340	43,560	21,780	14,520	10,890	8,710	7,260
30	17,500	210,000	105,000	52,270	34,850	17,420	11,620	8,710	6,970	5,810
36	14,500	174,000	87,000	43,560	29,140	14,520	9,680	7,260	5,810	4,840
42	12,500	150,000	75,000	37,340	24,890	12,450	8,300	6,220	4,980	4,150
48	11,000	130,000	65,000	32,670	21,780	10,890	7,260	5,450	4,360	3,630

Example: At a 24 inch between-row spacing there are about 22,000 feet of row per acre. There are 14,520 plants per acre when planted 18 inches between plants in rows 24 inches apart.

must be accurate. When using belt type seeders, the largest seed must pass easily through the holes in the belt, but not more than two of the smallest seeds should pass side-by-side through the same hole. Small quantities of seed can be graded at home or in the shop by using a series of sieves. Seed of cole crops (broccoli, brussels sprouts, cauliflower, cabbage), radish, beans, onions, rutabagas and turnips have been successfully sized. Onions and carrots present more of a problem because of their irregular seed shape.

Pelleted Seed

Pelleted or coated seed is available from many seed companies at considerably more expense than raw seed. Seed coatings vary in formulations and in the volume applied to seeds. Most pelleted seed in an individual lot is fairly uniform in size and can be used as recommended. However, occasionally a few larger pellets are formed and these can be a nuisance when seeding. A minimum rather than a maximum coating is recommended. Pelleted seed must have a high germinating capability. Seeds with a low germination count defeat the purpose of precision seeding and should not be pelleted. Pelleted seed used in Alberta has generally resulted in poor germination, particularly under a sideroll irrigation system. Frequent, light water application available through a centre pivot irrigation system generally results in better germination of pelleted seed.

PLEASE NOTE

Emergence is never perfect; therefore some crops should be precision seeded at double or triple the final stand. Cabbage and cauliflower are good examples. If a 30 cm (12 in.) in-row spacing is desired it may be necessary to plant every 15 cm (6 in.) to ensure a near perfect stand. In this case some thinning may be required,but, the time required to thin is greatly reduced compared to a crop sown by a conventional seeder.

Field Factor

Planting conditions are seldom ideal. The soil may be too wet or too dry, too cold or too warm, too loose or too packed. If soil conditions are good, most seeds will germinate, but fewer seedlings will emerge if conditions are poor.

The field factor is used to estimate soil conditions and the effect these conditions will have on seedling emergence. Under ideal conditions a field factor of 0.8 can be applied. Under normal conditions a factor of 0.6 - 0.7 is common. Under still poorer conditions, the factor can be 0.4 or 0.5 or even lower. Irrigation improves germination by increasing the field factor. Centre pivot systems offer the best germination and early seedling field conditions.

The field factor must be applied to viable seeds only. If a germination count of 80% was given and afield factor of 0.7 applies, only 56% of the seeds sown will emerge from the ground.

$0.8 \times 0.7 = 0.56$ or 56%

If the germination count is only 70% with the field factor of 0.6, only 42% of the seed will produce plants.

If a precise stand is required under these conditions, seeding should be done with a belt that will drop two seeds per hole rather than just one. An

alternative is to use a belt with twice as many holes. However, this may result in the need for thinning.

Winter(Fall) Seeding

For many years research staff at the Alberta Special Crops and Horticultural Research Center in Brooks have investigated the possibilities of seeding some field grown vegetables at the onset of winter. The concept was developed with the hope that such a practice would lead to early access to markets in the following season.

Initially, all crops were tested. It was soon evident that only crops with a high degree of frost tolerance were successful. The following crops are recommended with no specific varietal recommendations, since there appears to be little varietal advantage. Differences in maturity when winter sown can be dramatic.

Crop	Maturity Advantage When Winter Sown
Spinach	10 days earlier to optimum development
Lettuce, all types	2 to 3 weeks earlier to maturity
Onions (cooking)	2 weeks earlier to 50% tops down
Carrots	earlier sizing
Parsnips	earlier sizing

Actual time of seeding is critical as soil temperature at seeding depth must be at 5°C or colder. In southern Alberta this generally occurs in late October. Visual signs such as ice persisting throughout the day on ponds and frost evident during mid-day in shade of buildings helps to indicate that soil temperature is ideal for seeding. The grower is advised to prepare the seedbed well in advance of seeding and to do the actual seeding as late as possible. The success of winter seeding depends mostly on soil temperature at the time of seeding. The seed must lie dormant in the soil where free water for uptake is not available before freeze-up. Uptake of water by the seed before freeze-up will destroy viability when ice forms in the seed. It should be noted that the soil warms up very slowly and a few warm days do little to increase soil temperature. Many growers get unnecessarily concerned over brief warm spells that occur throughout the winter.

Soil condition of the seedbed is important. Heavy clay soils have a tendency to crust, and a thick crust can reduce seedling emergence. Choosing a lighter, more sandy soil texture has its advantages, however, some form of wind protection is advised. In southern Alberta, a few commercial growers have succeeded in holding the soil down by deep cultivation of furrows to create lumps and ridges.

Over many differing winter weather conditions, the viability of seed can vary and generally the more snow cover the better it is for the seed. The following table of figures indicates the percentage of seed that survives from the recommended seed drop.

Crop	Recommended Seed crop per 30 cm	Germination Per Cent	
		Spring Seeded	Winter Seeded
Carrots	40	60-70	25-40
Lettuce	10	60-70	30-40
Onions (cooking)	18	70-80	40-50
Parsnips	15	70-80	25-35
Spinach	20	80-90	50-60

All trials involved raw seed that was sown with Stanhay precision drill. Current research trials are using coated seed.

The resulting loss in seed viability with winter seeding necessitates the need for increased seed drop. The requirement can prove to be costly particularly when hybrid seed is used. As a result grower are encouraged to use less costly seed and increase the seed drop to attain a good plant stand and yield.

Crop	Recommended Seed Drop per 30 cm	
	Spring Seeding	Winter Seeding
Carrots	40	60
Lettuce	10	15
Onions (cooking)	18	30
Parsnip	15	25
Spinach	20	30

Aside from the reduced plant stand with winter seeding, some physiological disadvantages occur with a crop that experiences temperatures well below freezing early in the seedling stage. Carrots may bolt, onions may produce multiple growing points and lettuce may fail to head properly. The incidence of such physiological disorders is rare and is directly related to the duration and severity of low temperature exposure. A temperature of -8°C or greater appears to be critical.

Transplanting

The advantages of transplanting are numerous. In Alberta several vegetable crops will not mature if grown directly from seed in the field. Transplants provide the necessary advanced growth to ensure a harvested crop before frost.

Tomatoes, peppers, brussels sprouts, celery, eggplant, melons and other long and warm season crops are examples. Other crops, which will normally mature when direct seeded, can be transplanted so that they can be marketed early when prices are normally higher. This in effect extends the growing season of that crop. Examples include cabbage, cauliflower, broccoli, lettuce, cucumbers and squash.

Transplanting ensures a near perfect plant stand which maximizes other management inputs. Crops grown from transplants are normally more uniform in size, shape and maturity. These factors can reduce harvest and grading costs.

Transplants can also provide some degree of insect control. Emerging cabbage and other cole crop plants can be totally destroyed by flea beetle infestations in the field. A method of eliminating the need for chemical insect control is to use transplants. Although they will be attacked, strong transplants will normally survive flea beetle infestations.

Transplants are not cheap, and experience in transplant production is necessary if a grower is planning to grow his own. Importing transplants is a cheaper alternative practised by many growers.

For more information about transplant production and transplant equipment refer to Section 2 of this guide, Bedding Plant Plug Production, or contact one of the vegetable specialists listed on the back cover of this guide.

PRODUCTION OF WARM-SEASON CROPS

A warm season crop is one that requires a long warm growing season in which to mature its fruit. Cucumbers are an exception since the fruit is harvested in an immature stage. Warm-season crops are not as frost hardy as cool season crops. They need warmer soil temperatures to germinate and chilling injury can occur between 0°C and 10°C.

Crops such as watermelons and peppers require a warmer climate than do tomatoes and cucumbers. To satisfactorily grow and harvest warm-season crops, a number of techniques can be used to modify and enhance the growing conditions. These include using transplants, hotcaps, mulches, row covers and combinations of these.

Transplants

Transplants grown indoors and then transplanted into the field will advance production by 2-4 weeks. Transplants can be used for almost all warm-season crops and are generally used for tomato, pepper, eggplant and melon. Transplants can also be used to grow earlier maturing cool-season crops.

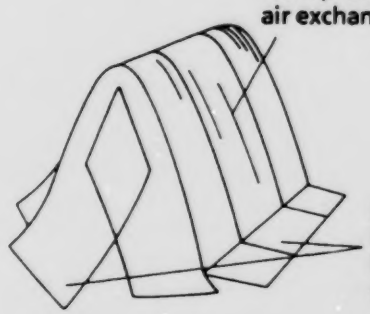
Hotcaps

A hotcap is a waxpaper tent held to form by thin wires. Hotcaps are available from most horticultural suppliers. Large size hotcaps are recommended because they allow for more space in which the plant can grow.

When using hotcaps, transplants can be put into the field 2-3 weeks earlier than normal as the hotcap provides two to four degrees of frost protection. Plants can be set out as early as May 15 with hotcaps for frost protection.

After the hotcap is placed over the watered-in transplant and soil is placed on the flaps to hold it down, a 5 cm (2 in.) cut is made on the leeward side (side opposite prevailing winds) of the hotcap. About once every week the size of the cut can be doubled for 4-5 weeks after field setting, at which time the hotcap can be removed. By this time the plants should be well established, and there should be no danger of frost. The hotcap is not reusable.

Hotcaps should be used with crops such as tomatoes, peppers, eggplants, melons, and may also be used on cucumbers, or any warm-season crop to advance maturity.


a small cut on the side away from prevailing winds allows for air exchange
place soil on all flaps around the base of the hotcap to secure it to the ground

Plastic Mulches

Various types of plastic mulches have been tested throughout the province, but to date both the clear and black mulch appear to be the most beneficial. When using clear mulch, a herbicide must

be used to control germinating weeds under the plastic.

Plastic mulches conserve soil moisture, transmit the heat that they absorb directly into the soil (soil temperature increases), and in the case of black plastic, control weeds. A number of crops have been tested on mulches; vine crops have been found to benefit most from their use.

The plastic mulch can be laid by hand or laid down with a commercial mulch applicator. There are several of these plastic mulch applicators in the province. A 2 mil by 120 cm (48 in.) plastic is most commonly used. The soil must be well prepared and smooth to ensure a tight union between the plastic and soil. This is especially important to allow for the efficient transfer of heat to the soil. Rototilling the soil prior to the application of the plastic mulch permits a smooth, lump-free soil surface. The edges of the plastic should be well buried with soil to prevent wind from picking up the mulch. Approximately 15 cm (6 in.) of plastic on both sides of the mulch is buried, so from a 120 cm (48 in.) wide plastic roll only 90 cm (36 in.) of mulch is exposed. Cross cuts in the plastic at 30 cm (12 in.) apart can be made down the centre of the mulch and seeds or transplants set into the holes. Spacing will depend on the crop planted. Care should be taken so as not to make holes too close together because wind may tear the plastic hole to hole and the mulch would therefore be useless. A plug-mix planter successfully plants seeds through the plastic mulch so the hand labor aspect of planting the crop is mechanized.

Normal irrigation practices will ensure adequate water supply.

Perforated Plastic Row Covers

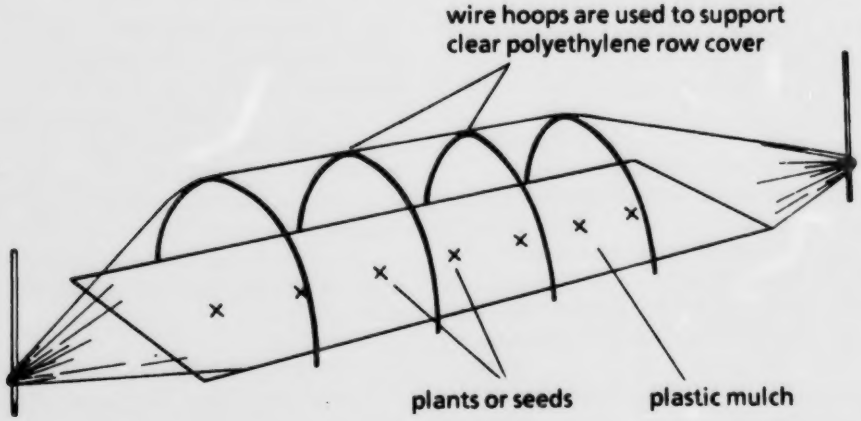
Row covers are of tremendous benefit when used in combination with black or clear plastic mulch. Row covers must be used in combination with plastic mulch otherwise severe moisture stress occurs and plants die. Vine crops appear to benefit most from the use of the row cover. Row covers are not recommended for use on tomatoes as fruit set is greatly delayed.

A 2 mil by 1.8 m (6 ft) wide roll of clear plastic is bored with 2.0 cm (3/4 in.) holes approximately every 30 cm (8 in.) in all directions. The holes are needed for ventilation. Current suppliers of row cover plastics in Alberta manufacture perforated plastic for use as row covers.

Wire hoops made of 180 cm (6 ft) pieces of no. 9 galvanized wire are placed over the row approximately 81 cm (32 in.) apart and each end of the wire should be inserted 15 cm (6 in.) into the soil. Wire inserting machines are available and eliminate this hand labor aspect. Galvanized wire is recommended to prevent rusting of the wire which speeds up deterioration of the plastic. The plastic is then stretched over the hoops, either by hand or by machine, fastened at both ends to a stake driven into the ground or held in place with soil and all edges are buried with soil.

Seeds should be planted into moist soil and transplants should be watered in before application of the row cover plastic. A plug-mix planter does a good job of planting seeds through plastic mulches; however, transplants must still be set by hand through plastic mulch. Roots will spread out quickly and normal sprinkler irrigation will ensure an adequate supply of moisture.

It is important to note that row covers give no frost protection unless a polyester (floating mulch)



Perforated plastic row cover

cover is used. Up to 2°C frost protection can be expected from these materials.

The row cover should be removed when vine growth reaches to the edge of the plastic cover, when flowering commences or when plants appear to be suffering from scorch.

The plants inside a row cover will be growing in a modified greenhouse atmosphere, thus removal of the tunnel should be done on a cool, cloudy day to reduce plant shock. Slitting the row cover down the middle at least two days before removal helps to gradually introduce the covered plants to the outdoor environment, then the row cover can be completely removed.

HARVEST MANAGEMENT

Vegetable and potato quality are directly related to harvest timing and post-harvest handling. Harvest timing is generally dependent on product maturity, which can be recognized by color change, skin set, size and numerous other factors. Harvesting at the right stage of maturity is often difficult but critical to good quality.

Whether harvesting is done by machine or by hand, care must be taken to avoid mechanical damage. Bruising can cause discoloration or decay and may reduce the grade of the product.

Vegetable quality in terms of flavor, color and size generally improves as a product reaches maturity. However, the perishable nature of vegetable products means that quality will begin to decline after a maturity peak is reached. Growers should be able to judge optimum maturity for all products produced.

Deterioration in quality continues after harvest, and how products are handled will determine the rate and eventual extent of the deterioration.

STORAGE AND STORAGE MANAGEMENT

Many vegetables can be satisfactorily stored for a relatively long term in the proper storage environment. Providing suitable storage conditions is the key to successful storage.

Storage design and planning may be considered in the following important categories:

1. Storage requirements of vegetable types and varieties is of first importance.
2. Environmental control - temperature, humidity, ventilation and related control systems and management.
3. Functional design - to provide the correct amount of storage, plus equipment and facilities for handling, grading and marketing of produce.
4. Structural - ensure that the storage building is designed for wind and snow loads, and the force of piled vegetables, earth pressure or equipment loads. Storage must be very well insulated with a good vapor barrier properly sealed and located.

This section summarizes storage requirements for typical market garden or smaller commercial production. The same principles apply to home storage of vegetables, though there is a large variety of these storage systems. Large, commercial storages require specialized design of the structure, cooling loads and related mechanical equipment.

Storage Conditions for Vegetables

Proper storage conditions are critical. These differ for various types or groups of vegetables. Table 3 summarizes these requirements. The notes following table 3 explain some of the more detailed aspects of storage management.

Obviously, since storage requirements differ, only those crops requiring similar conditions store well together; thus the groupings of table 3. Some groups of vegetables tolerate a compromise of conditions where shorter storage life or lower quality of one commodity may result. For example, both potatoes and root vegetables require high humidity; however, potatoes should not be stored cooler than 5°C, while root vegetables store best at 0°C. It is best to construct separate rooms for each. However, where these crops have to be storedtogether, store everything at 4-5°C, and high humidity. This results in somewhat shorter storage life (though good for 3 months) for root crops, without causing undue damage (sweetening) to the potatoes.

Though each crop has its storage requirement, the following recommendations are important for all crops:

- harvest only mature crops.
- grow varieties that store best.
- remove all diseased or damaged produce before storing.
- handle carefully to avoid damage.
- precool cold storage crops or try to harvest in cool conditions, such as early morning.
- wet floors of storage ahead of time (particularly earth floors).
- if frost-damaged, diseased or immature crops must be stored, try to store separately and market early.

Table 3.
Storage conditions for selected vegetables.

Storage Type	Produce[1]	Bulk[6] Density (kg/m³)	Pile Depth m	Pile Depth ft	Temp. °C	Relative Humidity (%)	Storage Period (months)
Cold and Humid	Beets	650	3-4	10-14			4-6
	Cabbage[4]	500	2-3	6-10			2-6
	Carrots	550	3-4	10-14	0-1	90-95	4-6
	Parsnip	500	2.5-3.5	8-12			2-5
	Radish	600	-	-			1-3
	Rutabaga	650	3-3.5	10-12			4-6
Cool and Humid	Potatoes - seed				4-5		
	- table	670	4-5	14-16	5-6	90-95	5-10
	- process[2]				7-9		
Cool and Less Humid	Pumpkin						2-4
	Squash[5]	500	1-1.5	3-5	10-12	70-75	4-6
Cold and Dry	Onions[3] (cured)	600-700	2-3	6-10	0-3	70-75	4-8

Notes:

1. Most produce, particularly cabbage and potato, react to light; store in dark conditions. Do not store vegetables and apples together because apples give off ethylene which causes off-flavors in carrots, parsnips and other vegetables.
2. Potatoes are normally cured 2-3 weeks at 10-15°C and high relative humidity, then cooled slowly to storage temperature. Storage conditions are highly dependent on variety and use.
3. Onions are either field cured, or cured in storage at 32-36°C with high air flow prior to long term storage.
4. Cabbage storage quality and time is highly variety dependent.
5. Squash and pumpkin should be well ripened; cure at 30°C then reduce temperature.
6. Bulk density varies 5-10%, use as a guide for estimating storage size requirements. ($kg/m^3 \times 0.0625 = lb/ft^3$ or $kg/m^3 \div 16 = lb/ft^3$).

Planning and Functional Design

The size, type and layout of storage should be determined. Several items to consider in making this decision are:

- the size and number of individual bins required
- varieties or types of produce; which ones may be stored together
- storage layout for convenient handling
- receiving and rough grading at harvest prior to storing
- future expansion or modification
- utilities and services required
- possible washing, grading or packaging facilities
- water supply and waste water disposal

Storage Size

Total storage volume, size and number of individual bins, should be considered. Storages vary from one large room to multiple-bin structures. Storage facilities with several bins or rooms are more costly. The advantages are smaller batches for better control, lower risk of storage losses and more flexibility in bin management.

Marketing requirements, varieties, cropping conditions, and storage management affect storage bin design. The seed potato grower or vegetable producer may need several bins, while the commercial potato producer will find one or two bin bulk storages are best.

Bulk storage size can be estimated from bulk density data (table 3). Plan storage capacity for above-average yield and future expansion or changes, such as an added grading room or loading shed, or refrigeration system. Remember that it is not usually feasible to fill storages full depth right to the doors, unless heavy doors or bulkhead systems are constructed.

Pallet bin type storage capacity is determined by laying out the required number of bins in tiers and rows. Stacking height is often determined by limits of

stacking equipment, usually 4 to 6 tiers high. Most pallet bins fit a 1200 x 1200 mm (48 inch) module. Therefore, the most efficient room size has inside dimensions equal to a certain number of rows plus 300 mm (12 inches).

Storage Types and Construction

Storages are of two general types, (1) bulk storage and (2) palletized storage. Various building systems can be adapted to either storage type. Storages can further be classified according to the produce type, or whether they are "refrigerated", "air-cooled" or CA (controlled atmosphere).

In general, most types of farm buildings can be a good storage, provided it is structurally adequate, well insulated and meets the functional needs. Environmental control, together with a good insulation system, is the key element to good storage.

Some of the most common storage designs used in Alberta are illustrated on page 11.

For *bulk storage*, the produce is piled in room-size bins, thus the pressure exerted by the pile must be contained by the bin walls. These forces are large and should not be underestimated in the building design. Ventilation of bulk storage is accomplished by blowing conditioned air through the pile of produce from a duct system placed under the pile.

Bulk storage is generally less costly. It is best for crops that can be handled in bulk and piled fairly deep such as rutabagas, beets, potatoes, onions, and to a lesser extent carrots and parsnips.

Palletized storage has the crop placed in large boxes (pallet bins) which in turn are stacked in the storage room. The crop does not exert pressure on the walls, thus the building needs to be designed only for climatic loads.

Pallet bin storage is generally used for crops that bruise easily or cannot be piled, such as fruit, cabbage, parsnip, carrots and greenhouse crops. Palletized storage allows mixing of varieties or types of crops, as well as crops from several growers. Bins can be selectively marketed, and "problem" bins can be removed with less danger of wide spread spoilage. It is the preferred storage for warehouses and plants where produce turnover is frequent.

Air of proper temperature and humidity is circulated between rows of pallet bins. Small numbers of pallets may be handled and stacked by fork-lifts, and pallet dumping equipment.

Most storages deal with high humidity and controlled temperature. Though storages may be made of wood frame, steel or concrete, high levels of insulation and moisture resistance are required. Vapor barriers must be thorough and effective. For the coldest Canadian climates, minimum insulation factors should be RSI 5.5 (R31) for walls and RSI 6.5 (R37) for ceilings.

Some principles to consider, whatever the construction type, are:

- insulate foundations, preferably on the exterior.

- pay particular attention to the thermal bridges or "cold spots" in normally good wall or roof systems that can cause serious condensation problems. Solid studs, steel purlins and beams, and discontinuous insulation at foundations or plates are typical problem areas.

- durability and ease of sanitizing are important.

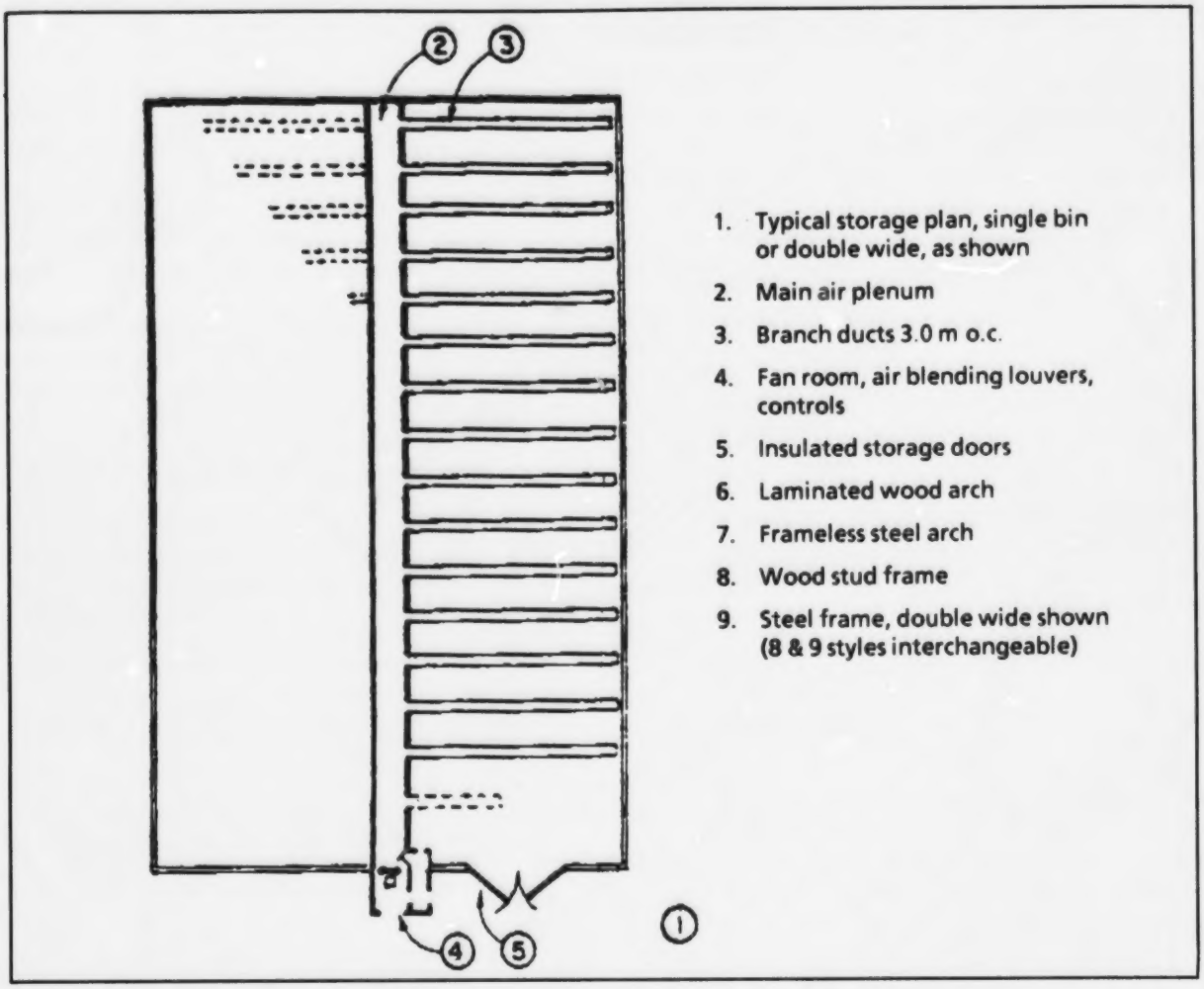
Structural Design Notes

Pallet type storage buildings, like other buildings, should be designed for wind and snow loads; however, consider the possibility of designing for a change to bulk storage in the future. Highest floor loads are caused by fork-lift wheels.

Bulk storage, in addition to climatic loads, must also withstand the wall pressure of piled produce. Bin walls require some structural engineering and these details are provided by Alberta Agriculture standard plans available from district agriculturist offices. Forces and bending stress can be great, and structural requirements should not be underestimated.

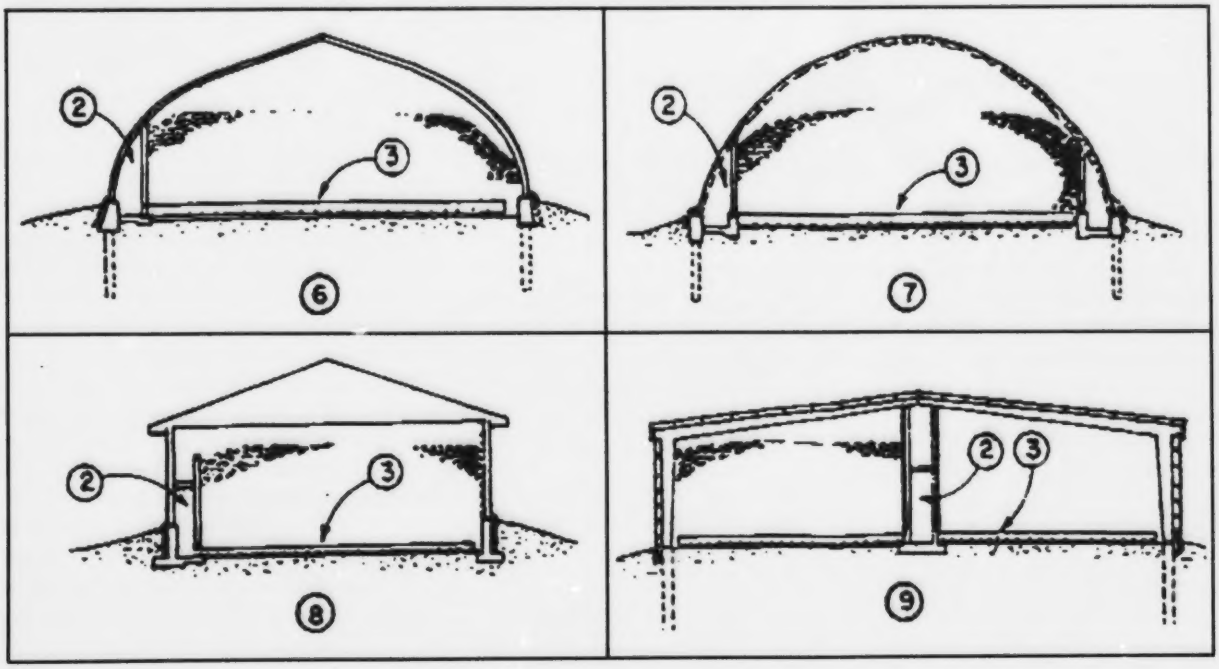
Pay particular attention to wall member strength, top and bottom wall connections, foundation side force, and force on rafters due to wall pressure. For example, a 4.8 m (16 foot) high potato pile exerts bottom and top plate forces of about 16.0 and 7.3 KN/m^2 (1200 and 500 pounds/sq ft) respectively.

Treated wood is not permitted in the interior of a vegetable storage, either where vegetables may contact treated wood or where moisture may drip from treated wood onto the produce. In wood frame construction, pressure treated sills and butt-treated studs are a desirable precaution against decay in these critical structural areas. Use water based CCA or ACA preservative. Do not use volatile and "smelly" pentachlorophenol or creosote.



1. Typical storage plan, single bin or double wide, as shown
2. Main air plenum
3. Branch ducts 3.0 m o.c.
4. Fan room, air blending louvers, controls
5. Insulated storage doors
6. Laminated wood arch
7. Frameless steel arch
8. Wood stud frame
9. Steel frame, double wide shown (8 & 9 styles interchangeable)

Typical potato storage plan and alternate building types



Construction Costs

The cost of new storages is highly variable depending on many structural and environmental factors. Too few vegetable storages have been built to determine average values, but good cost data are available for potato storages. In addition to the cost of storage space and related environment controls, a sizable portion of the project is sometimes required for the working area and grading and handling equipment.

Table 4 provides some typical costs for storages based on 1988 construction costs. These storages are well insulated, have concrete floors, and represent a range in building types.

A lower quality storage facility such as a root cellar can be built for up to half the above costs. Vegetable storage life, overall building life plus maintenance, and care of handling and operating will probably be compromised.

Environmental Control

This implies the control of temperature, humidity and air flow to provide proper storage conditions. This is accomplished by circulating the correct amount of conditioned air through the pile or past the pallet bins in a storage. Storages may be either "air-cooled" or "refrigerated" or both. CA (controlled atmosphere) is a new storage technology for cabbage storage that is adapted from apple storages.

Air-Cooled Storage

For air-cooled storage, temperature is controlled by blending the correct amount of cold outdoor air into the ventilation system. This requires outdoor temperatures below the storage temperature for all but short periods during most of the storage season. In general, this applies to potato, onion and squash storages. Non-refrigerated storage will work for other vegetable crops, but storage life may be reduced if there is difficulty maintaining cold conditions in the fall.

Ventilation is the movement of conditioned air past or through the produce to remove heat, maintain uniform conditions, and control humidity or condensation. This involves air flow rates and patterns, temperature controls, fans and duct design. Table 5 gives the recommended range of ventilation rates for vegetables.

For bulk storage, air is circulated through the pile by a fan and duct system. Temperature control is usually accomplished by a system of thermostatically controlled dampers that blend cold outside air with recirculated air. Controls should include; 1, a proportioning thermostat, 2, a low limit safety thermostat, 3, differential temperature sensor to prevent ventilation with outside air that is too warm, 4, timer, and 5, damper control motors. The proportioning thermostat controls the damper motors which set the ventilation temperature.

Design of the air handling and distribution system should adhere to sound engineering principles. Ducts should be free of obstruction and adequately sized. Under-pile ducts are spaced 2.4 to 3.6 m (8-12 ft) apart. Storages requiring high humidity should have a high-capacity humidifier as an integral part of the system.

Table 4.
Approximate Construction Costs for Vegetable Storages in Alberta.

Storage	Building Costs	Ventilation System
Bulk potato storage 1,000-2,000 tonnes	$85-$100/tonne	$10,000-$14,000
Bulk vegetable storage 500-1,000 tonnes	$150-$200/tonne	$10,000-$14,000
Palletized vegetable storage	$200-$250/tonne	
Pallet bins	$100-$150/tonne	
Refrigeration system for pallet or bulk type storage	$100-$150/tonne	(included)

Table 5.
Ventilation Rates for Vegetable Sources.[a]

Produce	Ventilation Rate[b] (L/s-tonne)	
	Bulk Storage	Pallet Bins
Potatoes -seed	6-8	10-12
-table	7-9	
-processing	8-10	12-15
Beets, Cabbage, Carrots, Parsnip	10-12	15-20
Rutabaga/turnip	8-10	15-20
Pumpkin, Squash		15-20
Onions - curing	40-50	60-80
- cold storage	10-15	15-25

Notes:

a. L/s.tonne x 1.92 = cfm/ton.

b. Ventilation rate for palletized storage is closely connected with refrigeration equipment air circulation capacity; thus, may vary considerably depending on the type of equipment.

Simpler, low cost ventilation systems, suitable for shorter term or smaller storages can be devised. There can be fans and ducts to circulate air through the pile, and manually operated doors and vents to bring in outside air for cooling.

Refrigerated Storage

Refrigeration is required for extended storage beyond the winter months, for early fall storage, and also for most "cold crop" storages. The refrigeration system should be designed to remove field heat, the heat of respiration and other heat gains. The system must operate effectively at high humidity , near-freezing conditions, yet minimize moisture loss from the produce. This requires a large coil area, adequate air flow, defrosting cycles and humidification.

In planning refrigerated, or air-cooled storage systems, it is important that the direction of flow of refrigerated or cooled air through the produce be from coldest to warmest produce (usually from back to front). Loading of the storage, and design of the air flow system, should be done accordingly. That way heat removed from warmer produce does not reheat vegetables that were previously cooled. Condensation caused by warmer air striking colder produce is also prevented.

Refrigeration to about 0°C is required for very long-term storage, for early fall storage and for most cold crop storage. The two systems generally available are direct coil units or "air-washing" systems. Each has its advantages and shortcomings. Cooling coils may be either direct expansion or chilled cooling fluid types. Systems can also be designed that combine outdoor air cooling to reduce refrigeration aerating costs. Refrigeration system design in detail is beyond the scope of this publication; however, it is important to remember to design refrigeration capacity to handle the necessary loads. The system must be able to handle:

- field heat from the produce (this is often the largest cooling load)
- respiration heat of stored fruits or vegetables
- heat gain through walls, ceiling and floor of the storage structure
- mechanical heat load from lights and meters and
- warm air infiltration.

When these cooling loads are taken into account, typical refrigeration capacity for vegetable storages should be:

- cold crops 120-150 w/t (400-500 BTU/h-ton)
- potatoes 35-40 w/t (120-140 BTU/h-ton)

Controlled Atmosphere (CA) Storage

It involves complete modification of the storage environment to create an atmosphere of about 5% carbon dioxide ($C0_2$) and less than 5% oxygen (Normal atmosphere is 0.03% $C0_2$ and 21% oxygen). This requires an air-tight storage and special environmental control equipment.

Air-tight storages can now be constructed using spray-applied foam insulation techniques along with gasketed cold-room doors. A breather bag and pressure relief trap have to be incorporated into the structure. Environmental systems for controlling $C0_2$ in CA storages are generally of two types; either a lime scrubber, which is a box containing lime through which the storage air is circulated, or a special gas-permeable plastic membrane apparatus. Refrigeration for cooling is otherwise the same as a "normal" storage.

CA storage technology for vegetables appears to be limited to cabbage; however, experience may expand its application. Cabbage keeps better and longer in CA storage, particularly their firmness and color. The added cost for the CA storage and related controls is probably 25-30 per cent more than a standard refrigerated storage.

Plans

Standard plans for commercial sized bulk vegetable storages and storage components, such as walls, doors and ceiling systems, are available from Alberta Agriculture. The following is a list of storage related plans available through your local District Agriculturist or Regional Engineering office.

Number	Plan Title
*6000	Fruit and Vegetable Storage (planning guide)
6110	Bulk Vegetable Storage Wall (Not Refrigerated)
6111	Bulk Vegetable Storage Wall (Refrigerated)
6112	Refrigerated Pallet Vegetable Storage Wall
6115	Bulk Vegetable Storage Interior Stud Wall
*6119	Hotbed and Coldframe
M-6121	Storage Doors
6312	Bulk Potato Storage (1100 tonne, side air plenum)
6314	Bulk Potato Storage (1900 ton-Three Bins)
6315	Bulk Potato Storage (650 ton-Two Bins)
Q-6313	Bulk Potato Storage (2500 tonne, 2-bin)
M-6319	Walk-in Cooler-Freezer
*6321	Small Rootcellar
*6330	Fruit and Vegetable Storage Insulation

M - Designates a metric plan.

* - This leaflet is the complete plan.

POTENTIAL YIELD AND RETURNS FROM VEGETABLE CROPS

Commercial

The yield and return figures given in the following table are a representative average for all regions of the province where vegetables for the commercial market are grown. Estimated yields, particularly for warm season crops, can be expected to increase in warmer regions of the province. Return figures will vary and depend to a large extent on the marketing channel used, whether wholesale, retail or direct to consumer sales. The figures in table 6 are based on wholesale trade. Production costs do not include planting, harvesting or storage equipment costs. Management plays an important role in determining profit or loss in any vegetable operation.

Market Garden

Market garden costs and returns vary greatly, depending on types of crops grown, location of market garden and the marketing method used. Most market gardeners do some gate sales and also market at a local farmers' market. Generally, there is very little mechanization on a market garden, and therefore there is more labor input which is a costly item and is usually supplied by family members. An estimated $740/acre production cost does not include planting, harvesting, and storage equipment costs. Price received for produce runs 10% or higher than it does at the commercial market.

MARKETING VEGETABLES IN ALBERTA

Vegetable growers in Alberta are generally classed into one of two major groups: 1. market gardener, 2. commercial grower. The method or route used to sell vegetables largely determines the group a producer falls into. Market gardeners are

Table 6.
Potential Yield and Returns From Vegetable Crops.

Crop	Average Yield (Tons/A)	Production Costs ($/A)	Gross Return ($/A)
Beans (snap)	4-5	350	1800
Beets	10	400	2600
Broccoli	2	1200	2600
Cabbage	10-12	550	3100
Carrots	10-18	500	2800
Cauliflower	6-7	1350	5800
Corn	1000 doz.	460	1600
Cucumbers - slicers	15	4800	8000
- picklers	7	3500	5000
Onions - cooking	20-25	1000	3200
Parsnip	7	400	3500
Potatoes	10-12	700	1400
Pumpkin, Winter Squash	15-20	800	3200
Rutabaga	12	340	4100
Zucchini	18	3000	6000

represented by the Alberta Market Gardeners Association. Commercial vegetable growers fall under the jurisdiction of a marketing board, which only regulates vegetable sales and not production.

Alberta Fresh Vegetable Marketing Board(AFVMB)

The regulations of the Alberta Fresh Vegetable Marketing Board apply to all field grown vegetables produced in Alberta with the exception of tomatoes. The AFVMB office is located at 220E - 12 Street A North in Lethbridge, T1H 2J1, phone 327-0447. All sales of produce which go through packers, wholesalers, retailers, restaurants, hospitals, etc. are considered as commercial production and therefore fall under the board's jurisdiction. Consequently, if growers sell their own produce at the farm gate or at a recognized farmers' market, they are considered market gardeners and are exempt from the AFVMB rules and regulations (vegetables sold to processors for freezing or canning are regulated by the Alberta Vegetable Marketing Board). A market gardener sells vegetables direct to the consumer whereas a commercial grower does not and it is the later type of sale that falls under the rules and regulations of the AFVMB. Further, potato sales are not regulated by the AFVMB even though they are a vegetable. Potato growers have their own organization, the Alberta Potato Marketing Board.

The Alberta Fresh Vegetable Marketing Board has a pricing committee that sets minimum prices for fresh vegetables. This committee is composed of growers, packers and wholesalers. Prices are set by telephone conference calls and must be ratified by a majority of AFVMB directors. All prices set are the prices paid by a produce buyer delivered to his warehouse or place of business. All sales must be made on AFVMB invoices which are available from the board office.

The AFVMB deducts a 2% fee from all vegetable sales. The 2% fee is for services provided by the board such as setting minimum prices, operation of the price line, mailing out price lists, lobbying federal and provincial governments on behalf of producers, promoting and advertising Alberta vegetables and other activities.

The one exception to fresh vegetable sales relates to sweet corn. Producers are permitted to sell corn which they have grown without delivering directly to normal channels of trade and without using AFVMB invoices if they obtain a producer vendor licence from the board. Producer vendor licences are available from the board office and a licence must be held for each location where corn will be sold. This may also require obtaining a pedlar's licence from the city, town or municipality where corn will be sold.

All producers of field grown vegetables, by regulation, are required to obtain annually a grower's licence from the AFVMB. There is a $70 annual charge for this licence. This still permits the producer to sell produce at the farm gate and at recognized farmers' markets.

Produce entering the commercial market must be graded to meet Canada grade standards. In a competitive market poorly graded produce is hard to

sell; therefore, producers are encouraged to grade their produce. Grade standards for each crop are given in Section 6 of this guide.

Often grade standards are closely associated with the container or bag used to hold the produce. In many situations wholesalers will not buy produce from a producer unless it is packed into containers that are accepted by the trade. Counts and weights are an integral part of the vegetable trade and producers are encouraged to check with their produce buyer early in the season and clarify container requirements.

The Alberta Market Gardeners Association (AMGA)

The AMGA is a voluntary organization that endeavors to promote and support the market garden industry. The association operates a toll-free produce information line, supplies gate signs and brochures for the public and information packages for market gardeners. Annual membership fees are: $75 first time members (full voting), $50 (full voting) and $25 (associate - non voting). The association may be contacted by writing the Alberta Market Gardeners Association, Bag Service 200, Brooks, Alberta TOJ OJO.

Market gardeners can sell vegetables at any of the estimated 110 farmers' markets scattered throughout the province. Alternative marketing methods include pick-you-own and farm gate sales. There are no regulations governing direct-to-consumer vegetables sales except for location. Vendors must obtain a peddlar's licence when selling produce within town or city boundaries. Produce stands on primary or secondary highways in the province are not permitted.

Improving Market Share

Each year brings on increased production of fresh vegetables that creates a supply/demand crisis both locally and out-of-province. Alberta growers not only face competition from local growers but competition also comes from production areas outside the province as producers everywhere expand production. To survive a producer must effectively market his produce. Catching the consumer's eye and increasing demand can be achieved through three elements of marketing: packaging, pricing and product quality.

Packaging

Packaging should be examined to determine if it is restricting products from potential markets. For growers selling produce to retail and wholesalehouse, the cost efficiencies provided by palletization are becoming increasinglyimportant. Aside from ease of handling and reduced damage to the product, more efficient use of expensive space in trucks, warehouses and storages will reduce unit cost of transportation and storage.

When considering packaging the following markings on produce packages are required:

- the name and address of the grower, packer or vendor (incudes master bags)
- the grade
- the net volume, weight or count
- for Canadian grown produce, "Product of _____" followed by either "Canada" or the province of origin
- bilingual labelling, whenever product moves across a municipal border
- Alberta regulations require metric markings.

Pricing

Pricing is regulated by the Alberta Fresh Vegetable Marketing Board for produce sold through wholesale channels. Price is established by the laws of supply and demand and will with a quick review of this law remind the producer that being able to supply product at times of high demand result in a greater return for the producer. Use of transplants, early maturing varieties and storage facilities will help to supply produce when supply is lower and demand rises. A grower should be familiar with supply and demand trends and gear production and marketing for the best advantage.

Finally, consider *product quality* as part of marketing. Consistent high quality produce is the most imporant element of marketing.

The Canada Agricultural Products Standard Act establishes compulsory minimum grade standards. To compete effectively with the competition, the producer is advised to pack above the grade standards. Use of tolerances provided in the grade standards is not a very long term economic way of getting rid of cull produce. Turning a quick dollar one season is not an effective marketing strategy.

Examine other ways of improving the quality of produce to complement good grading. Some examples are the removal of field heat from vegetables, which greatly enhances shipping quality and shelf life as well as extending the marketing period of highly perishable commodities. Proper cooling and storage facilities allow for longer storage of produce, which allows the grower to aim for high demand periods.

Crop Insurance

The Alberta government in co-operation with the Government of Canada has developed a comprehensive scheme of crop insurance protection for fresh vegetable producers. The Canada-Alberta

Packing specifications that are currently accepted in the market place are as follows:

Vegetable		Packing Specification
Beans	- green and wax	25 lb bulk boxed
Beets		24 bunches per box, 10 or 25 or 50, lb bulk per cello bag or box, 10 x 3 lb
Broccoli		iced, bunched, 40 lb per waxed box excluding crushed ice
Cabbage	- all types	25 lb mesh (Alberta only) 50 lb mesh bag or box
Carrots	- mini	24 bunches or 12 x 20 oz.
	- small	10 x 5 lb, 16 x 3 lb, 24 x 2 lb (Alberta only)
	- medium	10 x 5 lb, 16 x 3 lb, 24 x 2 lb, 10 lb (Alberta only)
	- jumbo	50 lb cello bag
Cauliflower		wrapped and unwrapped; 9, 12 or 16 per waxed tray box
Cucumber	- slicer	24 count per box
	- pickler	25 lbs per waxed box
Dill Weed		bunched
Lettuce		2 dozen per box
Onion	- cooking	10, 25 or 50 lbs mesh bag or 15 x 3 lb mesh bag
	- bunching	bunches of 24 or 48 per box plus crushed ice
	- pickling	25 lb bulk in mesh bag
Parsnip		12 x 1 lb cello bag or 25 lb bulk
Peas		10 lb box
Pumpkin		bulk
Radish		bunches of 25 or 48 per waxed box plus crushed ice
Rutabaga		50 lb box or cello bag
Squash	- winter	bulk
Zucchini		25 lb box

Crop Insurance Program is administered by the Alberta Hail and Crop Insurance Corporation. Each level of government plus the insured farmers share in the cost of all premiums.

The program provides coverage based on a percentage of the average yield. The coverge is provided to cover the cash costs of preparation, planting and care of a crop. The crops that can be insured under this program are: cabbage, carrots, sweet corn, cooking onions and rutabaga.

To be eligible a minimum of two acres of each crop must be planted. All production from insured acreage *must* be sold through the Alberta Fresh Vegetable Marketing Board; therefore, market garden produce sold directly to the consumer does not qualify for crop insurance coverage.

Deadlines are as follows:
Application: April 30
Election: April 30
Seeding: Varies by crop, contact local District Office
Reports of Seeded Crops: 10 days after the seeding deadline.
Pre-harvest in Section: Notice must be given two days prior to commencement of harvest.
Post-harvest Claim: November 30
Cancellation: March 31

The program operates on an individual grower basis and consequently the premium is not affected by crop loss claims made by other growers. Each producer stands on his own with this crop insurance program.

An endorsement providing spot-loss protection against hail is also available. Claims must be registered no later than three days after the storm.

To obtain applications or more information, contact the local District Office of the Corporation listed in the phone book under the Government of Alberta, Alberta Hail and Crop Insurance.

SECTION 2
BEDDING PLANT PLUG PRODUCTION

Plugs have become increasingly popular in recent years. Their popularity has grown with the development of less expensive plastic trays and the introduction of mechanical transplanters. Plugs are easy and fast to transplant, so crews can work more quickly and efficiently.

The production of plugs is not basically different from traditional methods of bedding plant production. Temperature, light, water, media and nutrients in proper balance produce healthy plants.

CONTAINERS

Trays

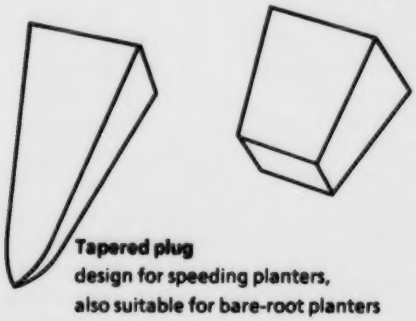
Selection of trays must be geared to the method used to transplant the plugs in the field. The bare-root mechanical transplanter is more versatile in that the plug size is less critical to trouble-free transplanting. The speedling transplanter, however, is more limiting despite its improved efficiency. For several years now the general observation and recommendation coming from growers using the speedling transplanter is that plugs from the 128 tray rather than the 200 tray are field set with greater accuracy. This is do to the slightly larger soil ball which is heavier and this added dead weight assists the plug to fall more quickly through the vertical shoot in the speedling transplanter model. Smaller, lighter plugs disorientate more frequently during the "drop". This is particularly true where soilless mixes have been used. The addition of compost or soil, being heavier, overcomes the problem and 200 trays can be successfully used.

It should be noted that trays with a tapered plug design must be used in all speedling models unless some modifications are made in the feeder cups to handle flat-bottomed plugs.

GROWING MEDIUM

One of the characteristics that makes a good plug growing medium is air porosity. The air porosity of the medium in a plug tray is usually 0 to 2 per cent. Amendments that may be used to increase air porosity to the desirable 20 per cent are sphagnum peat moss, vermiculite, perlite and calcined clay. The cation exchange capacity (CEC) is also important because it determines the amount of nutrients available to the plant. The CEC should be approximately 20 to 25 milligrams/litre. This is only a guideline and should be followed as closely as possible to provide optimum quality seedlings. If the CEC is lower, fertilizer will have to be applied more frequently.

The nutrient charge of the medium should be 1 to 2 millimhos/centimetre for soilless plugs and 0.8 to 1.5 millimhos/centimetre for plugs containing soil. The pH should be 5.8 and maintained between 5.8 to 6.5. Calicum and magnesium are usually too low in most media and should be monitored by growing medium analysis. Phosphorous should also be closely monitored. If the level is in a high range, it may tie up iron and cause a deficiency of this element.



Flat-bottom plugs
suitable only for bare-root planters

Tapered plug
design for speeding planters,
also suitable for bare-root planters

Suggested Mixture for Growing Medium in Plug Production

Ingredients	To Make One Cubic Yard
Shredded Sphagnum peat	½ yard^3
Vermiculite No. 2, 3 or 4*	½ yard^3
Limestone, dolomitic preferred	5 pounds
20% superphosphate (powdered)	2 pounds
Calcium or potassium nitrate	1 pound
Fritted trace elements	2 ounces
Wetting agent	3 ounces

*for a mineral based medium reduce vermiculite to ½ yard^3 and add ½ yard^3 sterilized loam.

Sterilization

If the growing medium, does contain soil, compost or some other non-sterile material, a sterilization procedure will have to be followed. The following methods can be used to sterilize bedding plant soil mixes.

Steam - Steam controls all disease organisms, insects, nematodes and most weed seeds. Steam sterilization is accomplished by passing large quantities of steam into the soil until the temperature becomes sufficiently high at the desired depth. For this purpose a steam boiler is required. A greenhouse steam boiler or a portable unit of about 200 kW (20 hp) may be used. For successful sterilization, the coldest part of the soil mass must be held at 82°C (180°F) for at least 30 minutes.

Formalin* - Commercial Formalin containing 37 to 40 per cent formaldehyde is effective against damping-off and various other disease organisms. Areas where sterilized or fumigated soil is dumped in bulk piles should previously have been wetted down with a solution containing 625 ml of formaldehyde in 25 L of water (1 pt to 5 gal). The same solution can be used for bulk soil applying 80 L of solution per m^3 of soil (13.5 gal solution/cubic yard of soil). The soil should then be covered with a plastic sheet for 48 hours. An aeration period of about two weeks is required, with frequent cultivation or stirring during the interval to allow the gas to escape. Seeding may safely be done when no odor of Formalin remains.

Methyl Bromide* - Apply at 45 to 90 g/m^2 (1.3 to 2.7 oz/yd^2) methyl bromide (98% LI) under a plastic cover and according to the manufacturer's directions. It controls most nematodes, most weed seeds and most disease organisms, but not verticillium wilt. (WARNING--Where celery is to be seeded, soil mix should be test seeded with celery well in advance of normal seeding time to ensure bromine residues will not affect germination and growth of celery).

Basamid - Basamid (98% G) controls nematodes, root diseases, soil insects and some weeds. Distribute 30 to 50 g/m^2 (1 to 1.5 oz/yd^2 or 130 to 200 kg/ac evenly on the soil surface. This can be done by hand (with rubber gloves) or by means of a fertilizer spreader. Incorporate to a depth of 15 to 20 cm (6 to 8 in.) and seal the soil by covering it with plastic sheets. The soil must be aerated before seeding can take place.

To use Basamid in soil mixes, incorporate 200 g/m^3 (200 oz/1000 cu ft) of soil. NOTE--The amount of time required for fumigation and aeration of the soil depends upon the soil temperature.

Chloropicrin*, Chloropicrin mixtures*, Vorlex, Vapam - These are effective for the control of damping-off organisms, verticillium and fusarium wilts, some weed seeds, some nematodes, and other soil pests. Follow manufacturer's directions.

Flats, Benches, Containers, Tools. To prevent spread of disease organisms and reinfestation of treated soils, all pots, flats, bins, beds, and tools should be disinfected using the following methods:

1. Steam. Items to be steamed should be placed on a bench, or stacked and covered with a tarpaulin, beneath which steam is released to maintain a minimum temperature of 82°C (180°F) for at least 30 minutes.
2. Formalin*. Used flats, etc. should first be cleaned of excess soil, then dipped for 5 minutes in a solution containing 625 mL of formaldehyde in 25 L of water (20 oz in 5 gal) or sprayed thoroughly with a solution containing 1 L of formaldehyde in 25 L of water (32 oz in 5 gal). Treated flats and benches should be kept wet by sprinkling with water for 4 to 5 days until all odor of formaldehyde has gone. Tools may be dipped in a solution containing 1.25 L of formaldehyde in 25 L of water (2 pt in 5 gal) and then rinsed in clean water and used immediately.
3. Methyl Bromide*. Empty flats, pots, etc., may be stacked, covered with plastic and fumigated with 160 to 325 g/m^3 (1 to 2 lb/100 cu ft) in the same way as if they were filled with soil.

* CAUTION, VERY TOXIC

DISEASE CONTROL

Damping-Off

This disease causes the greatest hardship for bedding plant growers because it occurs frequently and often takes several forms. Seed can rot in the soil, or seedlings can die before they come up or topple over after emergence. Stem tissues at the soil-line can become water-soaked and brown or black. Shrivelling of affected tissue may follow. Wirestem of cabbage is a form of damping-off, but seedlings too may fall over in this case.

To control damping-off, follow these recommendations:

1) Disinfect soil with Formalin (formaldehyde), steam, dry heat, methyl bromide*, chloropicrin*, Vorlex, Vapam, Basamid or use Captan 7.5 D at 1.2 kg/100 m^2 (2.5 lb/1000 sq. ft.) mixed into the top 7.5-10 cm (3-4 in.) of seedbed. For bulk soil, use 1.7 kg (3.8 lb) Captan 7.5D per 10 m^3 (13 cu yd).
2) Treat seed with fungicides.
3) Provide good ventilation.
4) Water in the morning.
5) Don't sow seeds to thickly.
6) Keep humidity low.

*CAUTION, VERY TOXIC.

If damping off appears, drench seedbeds with a water solution of one of the following fungicides: No Damp 2.5% SN at 15 m/L (0.5 fl oz/1.75 gal), Vitavax-Captan 30 W at 2.5 g/10 L (0.5 oz/10 gal) or Captan 50 W at 25 g/10 L (0.5 oz/gal). Apply enough solution to wet the soil to a depth of 7.5-10 cm (3-4 in.).

INSECT CONTROL

Aphids

Aphids are small pear-shaped, winged or wingless insects, which are usually pale green in color but sometimes black, yellow or brown. Aphids suck plant juices causing leaves to discolor, curl, wilt and eventually to fall off. Discolored spots can appear on tissue. Plant growth slows, and new buds may be malformed. Aphids also secrete honeydew, which appears as a shiny, sticky film on plant surfaces and acts as a medium for growth of a black, sooty fungus. Aphids may also transmit plant virus diseases. They are usually found on the tender portions of stems and undersides of leaves. Aphids can overwinter in the ground or in plant debris.

Prevention and Control
- Control weeds inside and around the greenhouse.
- Avoid bringing infested plant material into the greenhouse.
- Screen the vents and other openings to prevent entry from outside.
- There is no insecticide registered to control aphids on bedding plants; however, there is a list of products registered once transplant are set in the field (see individual crops in Section 6).

Fungus Gnats

Fungus gnats are small, delicate, dark grey or black flies about 3 mm long. They are often seen running on the soil surface or flying around potted plants, especially in wet areas. The slender white larvae have shiny black heads and live in the soil. Most species feed on decaying organic matter plus algae and are common in manure and compost. Larvae may damage roots on seedlings, rooted cuttings and young plants.

Prevention and Control*
- Avoid overwatering.
- Provide good drainage under greenhouse floor.
- Practice strict sanitation.
- Trap adults using yellow boards painted with a sticky substance (STP oil treatment works well) hung near the soil surface.

* There is no insecticide registered to control fungus gnats in bedding plants in the greenhouse. Please contact one of the entomologists or vegetable crop specialists on the back cover of this guide for assistance.

FERTILIZER

If a mineral based medium is used, 200 ppm of nitrogen and potassium should be applied in the irrigation water. For a soilless or artificial medium, it is suggested that 250 ppm of nitrogen and potassium be applied in the irrigation water.

When soluble fertilizers are applied, enough irrigation water should be used to moisten all of the medium in the tray. There is a danger of soluble salts accumulation if the medium is not watered thoroughly. Also, wash off liquid fertilizers to prevent burning leaves.

Dry fertilizers such as 5-10-5 and 5-10-10 should not be mixed with bedding plant medium with the expectation that enough fertilizer can be added to last the life of the plug. There is the danger of adding too much and also a difficulty in blending it uniformly with other ingredients that make up the growing medium.

WATER QUALITY

Boron, sodium chloride and bicarbonate are four components of water that should be closely monitored. The boron concentration should be less than one ppm and the chloride concentration should be less than 10 ppm. The sodium absorption ratio should be tested and calculated to determine the effect of sodium on the growth of plug seedlings. The sodium absorption ratio takes into account the total amount of sodium, calcium and magnesium. Water that has a sodium absorption ratio greater than two may be harmful to plants. Bicarbonate is the substance in water that cause the pH of the medium to increase. The total amount of bicarbonate should be less than four milligrams/litre.

To control the pH of the plug medium, use an adequate amount of phosphoric acid to provide 35 to 50 ppm phosphorous. This is enough phosphorous so that no additional sources of phosphorous may be needed. If the pH requires further adjustment, sulfuric acid may be added to the water to lower the pH to 5.8.

MOISTURE MANAGEMENT

One of the most critical aspects of plug production is the proper application of water. During the germination stage, water should be applied as a fog or fine mist. Mositure may be applied with a boom irrigation system, but careful attention must be given to avoid overwatering. Once seedlings have begun to emerge, less water will be required. By applying less water, the medium will not be saturated and will allow more aeration to occur. Once plants approach the size required to field set, plants should be watered throughly and dried to almost the point of wilting before irrigating.

TEMPERATURE

Germination temperature will generally be the highest during the growth of the plug. Temperatures approaching 27-30°C (80-85°F) are recommended. After germination the temperature is reduced to 21-22°C (70-72°F) to provide for optimum photosynthesis. To harden-off plants the temperature should be decreased to 15-18°C (60-65°F).

LIGHT

Maximum light is always recommended and should approach at least 4500 foot candles even on a cloudy day.

FIELD TRANSPLANTING

The bedding plant plug is meant for immediate transplanting into the field. Sometimes the weather does not co-operate and plugs have to be held over. Holding over actively growing plants slows their growth process and adds to time of production. When plugs are held over longer than one week, loss of actively growing root hairs occurs. Plants may also become root bound and root bound plants do not take off as quickly, increasing total crop time.

Before field transplanting, water plug trays a couple of hours beforehand - this makes them easier to dislodge. A starter ppm solution of 10-52-10 (3 to 4 lbs in 50 gallons water) or similar starter fertilizer will provide the early boost required by these transplants to set new roots in the field.

If purchasing plants grown in plug trays, the plants are usually pulled (popped) from the trays and place in waxed cardboard boxes and shipped or picked up by the grower. If these plants cannot be planted upon arrival, the grower must ensure that the roots do not dry out and that the plants do not

Vegetable Plug Production Requirements

Crop	Number Weeks Required	Temperature Required °C (°F)		
		Emergence	After Emergence	Growing-On
Broccoli	6-7	24 (75)	15 (60)	10 (50)
Brussels Sprouts	6-7	24 (75)	15 (60)	10 (50)
Cauliflower	6-7	24 (75)	15 (60)	10 (50)
Cabbage	6-7	24 (75)	15 (60)	10 (50)
Celery	9-10	24 (75)	15 (60)	10 (50)
Eggplant	7-8	27 (80)	21 (70)	15 (60)
Pepper	7-8	27 (80)	21 (70)	15 (60)
Tomato	5-6	27 (80)	18 (65)	15 (60)

remain in the dark for an extended period. Opening the boxes and exposing the plants to full sunlight is preferable to storing them in refrigerated storage. The goal is to keep roots healthy and actively growing. Temperatures favorable for growth (20-25°C) are optimum for holding these plants for short periods of time. Soil temperature should not drop below 16-18°C.

A critical factor in field establishment of transplants is proper field bed preparation. The objective is to create a soil environment that is conducive to the regeneration/generation of new roots that will become established in the field soil. Temperature is, of course, the most important soil factor, for all crops have a threshold temperature below which no root growth will occur. Growers must be aware of the sensitivity of their crops and monitor soil temperatures in the early spring. High soil temperature in summer plantings can also be detrimental by causing girdling of the transplants at the soil surface. Irrigation soon after transplanting will cool the soil surface and help prevent girdling.

It is not necessary to have a finely prepared seedbed when transplanting most vegetables. It is better to till a minimal amount to preserve the soil structure and moisture than to overwork the soil to get it perfectly smooth and clean. A rough field bed also helps reduce wind and sand abrasion of young transplants. Transplanting equipment can be modified with coulter and/or disk openers to plant in field beds with considerable trash on the surface.

Moisture is a mandatory requirement. Planting into a dry field bed can be devastating. Water is necessary for root growth, and roots will not grow through dry soil "in search of water". Therefore, the grower must ensure there is adequate moisture in the root zone at the time of planting or irrigate thoroughly immediately after planting. There are, however, two things growers can do to help survival when planting in dry soil conditions. First, till the soil as little as possible, for each time it is disked or dragged valuable moisture is lost. Second, if using starter fertilizer, decrease by 50 per cent the amount of soluble fertilizer in the starter solution, making water more available to the plant.

Depending on soil type, it may be possible to increase the volume of starter solution, but care must be taken to make sure that plants do not float out of the furrow before the press-wheels firm the soil around the roots. On sandy soils with high infiltration rates, it is possible to double the amount of starter solution per plant with no planter problems. The additional water is beneficial under dry soil conditions for a short period but cannot sustain the plant for more than a few hours.

Overhead irrigation is very important after transplanting to build the water reserve in the root zone, but care should be taken not to saturate the soil. Post transplant irrigation also assists by settling the soil around the roots, building the humidity around the leaves, and cooling the soil when it is extremely hot.

Equipment available for transplanting is very effective, but it must be properly adjusted and calibrated. Depth of planting is critical and can be adjusted on the planter. Most vegetable crops should be planted slightly deeper than they were in the greenhouse. The root ball should be completely covered with soil. Tomatoes are an exception and can be planted much deeper with no detrimental effects due to their unique ability to initiate adventitious roots from the stem.

Workers placing plants in the planter mechanism must be instructed about the proper placement of the transplant so that the desired depth of planting can be achieved. Poorly trained workers can damage transplant by crushing stems, breaking off terminals or damaging the leaves.

If growers pay close attention to each step in the transplanting process, they should have a good stand and good production of the crop.

SECTION 3
PEST MANAGEMENT

WEED CONTROL

Control of weeds is an input cost that can be reduced through good land management. Generally, weeds are best controlled by a combination of cultural and herbicidal methods.

Cultural Weed Control

Cultural weed control pertains to non-chemical methods such as tillage, hoeing and mulching. Several options are available:

- summerfallow - particularly valuable in controlling perennial weeds.
- crop rotation - including cereals in the rotation which permits the use of broad spectrum herbicides to control weeds.
- black plastic mulch - can be fairly expensive.
- green manure - rather than summerfallow, a green manure crop plowed down before weeds set seed, adds valuable organic matter to the soil.

The main goal of cultural weed control is to prevent weeds from setting seed or spreading by underground rhizomes and stolons; this is the strategy for long-term weed control. Weeds continue to be a problem year after year because they are prolific seed producers and seed of many species can remain dormant in the soil for years. Researchers have reported that even after maintaining perfect weed control in an area for three years, growers still experience weed problems in subsequent years. Weeds have the potential to rapidly increase and reinfest a field once vigilance is relaxed.

Weed seeds are spread by wind, water, animals and humans. However, the main source of reinfestation and increases in weed populations is the result of seed production from existing weeds in a field.

The following points should be observed in a long-term weed prevention program

1. Stop existing weeds from producing seed; remove or kill before seed setting.
2. Avoid planting weeds; check crop seed or transplants for presence of weed seed.
3. Avoid spreading weeds: thoroughly clean tools, tractors and other implements before moving them from one area (especially if weed infested) to another. Prevent weeds from setting seed on uncropped areas - fence lines, roadsides and farm yards. Keep irrigation ditch banks and structures weed free to avoid weed seed being spread by water flow.
4. Block importation of weeds: inspect transplants and tubers for weed seeds or rhizomes of perennial weeds. Thoroughly compost manure from livestock that have been fed weeds or screenings, grain or hay containing weed seeds, until most weed seeds have been killed.

For more information on non-chemical pest management, please consult "Guide to Crop Protection in Alberta, Part 2 - Non Chemical Control" Agdex 606-2, available from the nearest district agriculturists' office.

Chemical Weed Control

There is no one herbicide that will control all weeds in all crops. Herbicides are selective in the weeds they will control and also the crops that will tolerate the herbicide.

Weed identification is important for making proper herbicide selection plus proper application of herbicides is important to ensure success. Optimum growing conditions enhance herbicidal activity. Weeds are generally most susceptible to herbicides at the seedling stage. Weed seedlings can be identified with the help of the publication titled "Weed Seedling Identification", Agdex 640-3, available from the nearest district agriculturist office.

SITE PREPARATION

The vegetable production site should be free of perennial weeds. Perennials are virtually impossible to control when they are growing in combination with vegetable crops.

To control perennials, Roundup can be applied to actively growing weeds in the fall or spring prior to planting any crop. For quackgrass control, apply to actively growing quackgrass when at least four new leaves are present. The low rate (1 L/ac) will provide control for at least one season. This rate must be applied in 20 to 40 L/ac of water using flat fan nozzles. Delay cultivation for 5 days or more after application.

Canada thistle should be treated in the year prior to crop production. After summerfallowing until late July, allow Canada thistle to regrow for a minimum of 5 weeks until the rosette stage has a diameter of at least 15 cm. Delay cultivation for a minimum of 10 days after spraying.

The use of Roundup at higher rates (1.9 to 2.8 L/ac) at the bud stage is recommended for long-term control.

More detailed information on most herbicides is available by obtaining a copy of "Guide to Crop Protection in Alberta, Part I - Chemical" Agdex 606-1. Copies are available from the nearest district agriculturists' office.

STALE SEEDBED TECHNIQUE

Gramoxone (paraquat) may be applied before crop emergence to kill emerged weeds.
A stale seedbed involves the following steps:

a) preparing a seedbed 2 to 4 weeks in advance of seeding to stimulate weed emergence.
b) seeding is done without re-working the seedbed.
c) a non-selective contact herbicide is applied to "burn off" emerged weeds before the crop itself has emerged.

Gramoxone (paraquat) 200 g/L is registered for the stale seedbed technique for beans, red beets, carrots, cole crops, corn, cucumbers, onions, peas, potatoes and rutabagas (turnips). Apply Gramoxone at 1.1 to 2.2 L/acre in 120 to 445 L of water per acre no later than three days before crop emergence. Use the higher rate when weeds are above 5 cm in height, and higher volumes of water on dense weed growth. Gramoxone does not provide any residual weed control. Thorough spray coverage of the foliage is essential for good results.

TREATMENT OPTIONS

Preplanting (PPI) Treatments

Preplant incorporated (PPI) treatments are applied before the crop is sown or planted. These herbicides generally kill weed seedlings soon after germination. Most herbicides used for these treatments must be thoroughly incorporated into the soil by cultivation such as disking or rotovating immediately after application. Soils should be free of large clods and trash to permit uniform incorporation.

Pre-emergence (PRE) Treatments

These materials prevent emergence and provide early kill of many weed seedlings without reducing crop stand. This type of material should be applied immediately after seeding or at least before emergence of the crop. If these materials are applied after weeds have emerged the kill is usually poor. Best results are obtained with pre-emergence herbicides when conditions for weed seed germination are good. Rainfall or irrigation water applied after application of the herbicide is required to activate these herbicides.

Postemergence (POST) Treatments

These chemicals are applied after the crop plants are up, or after the crop has been transplanted. Weed seedlings must be correctly identified in order to select the proper herbicide. Applied as directed, the weeds can be killed without injury to the crop. The weeds should be small for best results. Good growing conditions usually enhance weed control.

CROP INJURY FROM HERBICIDE DRIFT AND RESIDUES

Spray drift can damage or destroy susceptible crops and shrubs for a great distance from the sprayer. Do not use 2,4-D, MCPA or dicamba or ester formulation of 2,4-D or MCPA herbicides near susceptible crops such as beans and tomatoes. Take into consideration both the direction and speed of the wind when applying this type of herbicide. Use low pressures whenever possible; 205-240 kPa (30 to 35 lb/sq in.) is usually enough. DO NOT USE THE SAME SPRAYER FOR APPLYING 2,4-D AND SIMILAR HERBICIDES AS YOU USE FOR SPRAYING INSECTICIDES AND FUNGICIDES. Drain thoroughly and wash out the sprayer immediately after use. DO NOT MIX DIFFERENT HERBICIDES OR HERBICIDES WITH OTHER PESTICIDES, FOLIAR FERTILIZERS, SURFACTANTS, OR DETERGENTS UNLESS IT IS RECOMMENDED BY COMPETENT AUTHORITIES.

Herbicide residue is a concern when planning your crop rotation or when purchasing or renting new land. Some residues can be introduced through application of straw and manure. Use the following as a guide which is based on normally used rates.

Trade Name	Common Name	Longevity in Soil
Aatrex, Atrazine	atrazine	2 years +
Afolan	linuron	1 year +
Ally	metsulfuron methyl	2 years
Amitrol-T	amitrole	2-4 weeks
Assert	AC222, 293	2 years
Atra-Mix Concentrate	atrazine + oil conc.	2 years +
Avadex BW	triallate	1 season
2,4-D	2,4-D	10 weeks
Banvel	dicamba	check label
Devrinol	napropamide	1 year +
Edge	ethalfluralin	1 year +
Fortress	triallate + trifluralin	1 year +
Glean	chlorsulfuron	4-5 years
Heritage	trifluralin	1 year +
Lexone	metribuzin	1 year
Lontrel	clopyralid	2 years
Lorox	linuron	1 year +
Primextra	metloachlor - atrazine	2 years
Pyramin	pyrazon	1 year
Sencor	metribuzin	1 year
Simazine	simazine	2 years +
Sinbar	terbacil	2 years
Tordon 202C*	picloram + 2,4-D	3-5 years
Treflan, Rival	trifluralin	1 year +

* may be introduced through contaminated straw or manure

INSECT CONTROL

Specific recommendations are listed under each crop in the production recommendations section of this publication. Growers wishing more detailed information should contact one of the insect control specialists listed on the back cover of this guide.

Following are general guidelines for controlling insects:

1) Examine plants frequently throughout the growing season to detect insect infestations in their earliest stages. The best control is achieved when insecticides are applied to the young stages of insects.

2) On some crops, one insecticide will control more than one insect pest. Choose an insecticide to control the main insect pest, then see whether or not it will control the others.

3) Some of the insecticide recommendations in this guide are expressed in ranges. Use the lower rates and volumes when plants are small; use the higher rates and volumes as the size of the plants increase. For best results, spray both sides of the leaves.

4) Practise crop rotation whenever possible. Growing crops that are not susceptible to the same pests prevents build-up of serious pests.

5) Practise sanitation (destruction of crop refuse and good weed control) to help prevent insect pests from completing some stage of their life cycle or from being protected during the winter.

General Pests

Cutworms

Several species of cutworm damage plants. They are soil-dwelling, fleshy and caterpillar-like, up to 25 cm long when fully grown, and characteristically curl up when disturbed. Most feed at night, destroying seedlings and transplants by cutting them off at or just below ground level. A few species climb plants and eat foliage or fruit.

Adults are the well-known 'miller moths', which are attracted to lights in mid-summer. Common species such as the red-backed cutworm overwinter as eggs in the soil. These hatch in early spring and cutworms feed on nearby weeds or crops until late June, pupating in the soil. Adult moths emerge in July or August. There is one generation a year.

Preplanting Soil Treatment Using Lorsban 4C*

Crop	Type of Cutworm	Rate	Remarks
broccoli brussels sprouts cabbage cauliflower celery chinese cabbage cucumber green pepper potato rutabaga tomato	dark-sided and red-backed	1.1 L/ac	Apply once in 80-160 L/ac of water 3 to 7 days before planting or transplanting. DO NOT incorporate. Application should also be made to a 15 m (50 ft) strip into nearby crop or rows.

*See under individual crops (Section 6) for alternative control products.

Postplanting Treatment (Seeding Treatment) Using Lorsban 4C*

Crop	Type of Cutworm	Rate	Remarks
bulb onion carrots	dark-sided and red-backed	1.1-2.2 L/ac	Apply in 80-160 L/ac of water at seedling (2-5 leaf) stage when first damage appears.
broccoli brussels sprouts cabbage cauliflower celery chinese cabbage corn cucumber green pepper potato rutabaga tomato	dark-sided and red-backed	0.6-1.1 L/ac	

*See under individual crops (Section 6) for alternative control products.
Follow label directions for intervals between the treatment and harvest.

Effective control is dependent on the proper timing of insecticide application. Many insecticides have short residual activity and break down quickly in sunlight. Most species of cutworms go into the soil during the day and come out to feed at night. Thus, most effective control is obtained by treating in late afternoon or early evening just before the cutworms come out to feed. Lorsban 4C is particularly effective when the soil is moist; higher rates may be necessary under dry conditions.

Slugs

Slugs are greyish-brown, soft-bodied, slimy creatures up to 30 mm long, which leave glistening trails. They feed mostly at night by rasping holes in plant foliage. Small backyard gardens provide favorable humid conditions and debris under which slugs can hide.

Slugs overwinter under boards or debris, or in soil as clear, spherical eggs or sometimes as adults. Eggs hatch in late spring, and young slugs are usually observed in mid-summer. There is only one generation a year.

Metaldehyde and Mesurol are the only slug control products registered in Canada. Where slugs are a problem, treatment should be applied while plants are in the seedling stage. Poisoned baits are most effective when applied early in the season before slugs begin feeding on mature plants. Apply commercially available baits in the evening around the base of plants and to the edges of headlands.

Wireworms

Larvae are injurious. They are shiny, yellowish-brown, somewhat cylindrical and distinctly segmented. They cause wilting and poor germination by boring into seeds and underground plant parts. Potatoes particularly are tunnelled and may later rot.

Adults are the so-called black or brown 'click' beetles. Females deposit eggs in the soil in spring, usually in grassy or weedy areas. On hatching, larvae feed on plant parts below soil level. Three to seven years are required by most destructive species to complete their life cycle.

Wireworms are most likely to be a problem the first two years after sod breaking. They can be controlled by planting treated cereals for two years, then growing vegetables, or by using a seed treatment of Agrox D-L Plus (lindane, diazinon and captan) at rates recommended on the label for large seeded vegetables such as peas, beans and corn. Other insecticide alternatives are: Counter 15G at 75 g/100 m, at 100 cm (3 ft) row spacing (3 kg/ac) directly in the seed furrow behind the seeder coulter or Dyfonate 10G at 4.5 to 5.6 kg/ac applied in a 20 cm (8 in) band at seeding time or at 17.8 kg/ac broadcast prior to planting and immediately incorporated to 5 cm (2 in) depth.

Grasshoppers

Adults and nymphs of several species chew all green plant material. Adults of most species are winged; nymphs are wingless.

Most economic species overwinter as eggs in pods in the soil. They hatch in early spring and young hoppers feed for 2-4 weeks before the final moult to the adult stage. Adult females begin egg-laying in late July. Serious outbreaks may occur after 2-3 years of hot, dry weather and good snow cover, particularly in low rainfall areas of southern and eastern Alberta.

Spray when grasshoppers are small for best results. Apply in 20 to 40 L/ac of water one of the following: Malathion 50 EC at 0.8 L/ac or Malathion 85 EC or Cythion 1000 at 400 mL/ac; Dimethoate 480 EC, Cygon 4E, Sys-Tem 480 EC or Lagon 480 E at 170 mL/ac; or Sevin 80S at 0.6 kg/ac or 50W at 0.9 kg/ac.

Note: Before using one of these insecticides on a vegetable crop, be sure it is registered for use on that crop.

BEE POISONING

Pollinating insects, especially honeybees are necessary for pollination and fruit set in vine crops with limited function, in peas and beans and also in pepper and eggplant crops. An insecticide application that is harmful to honeybees should be of concern to vegetable growers.

The following are a few points to consider and remember in the prevention of bee poisoning.

1. Do not spray any flowering crop on which bees are foraging. If insecticides must be applied, spray in the early morning or in evening when bees are not foraging. Bees usually do not forage at temperatures under 13°C.

2. If it is necessary to apply an insecticide poisonous to bees when they are foraging, notify neighboring beekeepers so they may protect their bees.

3. Do not apply insecticide on windy days because drift toward any nearby beehives may cause bee poisoning.

4. Ground applications are generally less hazardous than aircraft applications, and there is usually less drift.

5. Where there is a choice and bees will possibly be poisoned choose the formulation less hazardous to bees. Dusts are more toxic than sprays. EC formulations are less toxic than WP formulations.

Note: Most organophosphate and carbamate insecticides are highly toxic to bees. Those insecticides used in vegetable production and which are toxic to bees are listed here:

Relative Toxicity of Insecticides to Honeybees

Group 1 - Very toxic; Do not apply to flowering crops or weeds.

Ambush	permethrin
Belmark	fenvalerate
Birlane	chlorfenvinphos
Dasanit	fensulfothion
Diazinon, Basudin	diazinon
Dibrom	naled
Dimethoate, Cygon, Sys-Tem, Lagon	dimethoate
Furadan	carbofuran
Guthion	azinphosmethyl
Lannate	methomyl
Lorsban	chlorpyrifos
Malathion, Cythion	malathion
Monitor	methamidophos
Parathion, Aqua	parathion
Phosdrin	mevinphos
Ripcord, Cymbush	cypermethrin
Sevin	carbaryl
Temik	aldicarb

Group 2 - Apply only during late evenings or early morning. See note below.

Decis	deltamethrin
Di-Syston	disulfoton
Dyfonate	fonophos
Ethion	ethion
Methoxychlor	methoxychlor
Metasystox	oxydemeton-methyl
Pirimor	pirimicarb
Systox	demeton
Thiodan	endosulfan
Trithion	carbophenothion

Note: Unusually low temperatures at time of application may cause insecticides to remain toxic up to 20 times longer than during reasonably warm weather. High temperatures in the early morning or late evening may extend active foraging by bees and adversely affect bees on treated crops. OTHER INSECTICIDES LISTED IN THIS GUIDE CAN BE APPLIED AT ANY TIME WITH REASONABLE SAFETY TO BEES.

DISEASE CONTROL

Compared with major production areas where vegetable production is often more intense and where humid conditions exist, Alberta is relatively free of serious diseases on vegetable crops. However, severe disease outbreaks can occur and growers should be familiar with preventative and control measures. For more detailed information on disease control on a specific crop, contact one of the disease control specialists listed on the back cover of this guide.

A special section is included here on the control of disease before and shortly after germination. Seed treatments, sterilization of transplant soil and equipment, and disinfection of storage and associated equipment can all play an important role in the prevention of diseases both in the field and in storage.

Specific disease control recommendations are listed in the production recommendations section of this publication. The following are general recommendations for controlling diseases:

1) Prevention of damping-off through use of fumigated or steamed seed beds, pesticide soil drenches, proper cultural practices (especially watering), and seed treatment fungicides

2) Hot-water treatment of seed for elimination of certain seed-borne diseases

3) Rotation of crops so that those susceptible to the same diseases are not planted year after year in the same field

4) Sanitation (destruction of crop refuse) to reduce the probability of diseases in subsequent crops

5) Isolation, roguing, and control of insect vectors to minimize the spread of virus diseases

6) Use of resistant varieties

7) Use of fungicides and bactericides for prevention of foliar diseases.

SEED TREATMENT

Most seeds must be treated with a fungicide to protect them against decay in the soil and damping-off as young seedlings. In addition to this, certain kinds of seeds require special treatment to kill any parasitic fungi or bacteria that may be present in or on the seed, unless the seed has already been treated by the seed company. Seed treatment with an insecticide-fungicide mixture should be done not more than three months before planting.

For methods of application and quantities to use, see label directions on the pesticide container. Nearly all seed treatments recommended are made up in two ways: 1) for dust treatment or 2) for slurry. The slurry treatment is safer for the operator and gives better coverage.

To ease the flow of seed through the drill or planters, add 30 g (1 oz) of graphite per 20 to 25 kg (50 lb) of seed.

NOTE--SEED TREATED WITH EITHER FUNGICIDES OR INSECTICIDES MUST NOT BE USED FOR FOOD OR FED TO LIVESTOCK.

Seed treatment with fungicides and insecticides does not necessarily ensure freedom of the plants from all diseases and insects, but they may be an effective means of prevention.

Chemical Seed Treatment

All vegetable seeds should be treated with Thiram or Captan fungicide to reduce losses from seed decay and damping-off. In addition, large seeded crops such as beans, corn, peas and cucumbers can be treated with lindane insecticide to control wireworms or diazinon to control seed maggots. When purchasing commercial seed stock, be sure to specify what seed treatment is required.

VITAVAX rs Flowable may be used to protect direct seeded cole crops from flea-beetles. For cabbage, cauliflower, broccoli, Brussels sprouts, and rutabagas treat seed at a rate of 22.5 mL or 31 grams per kilogram prior to seeding. Ensure that product is uniformly mixed before using. Place seed in a clean glass or plastic jar not more than one-third full. Add required product to surface of seed. Close jar and shake vigorously with a swirling motion until product is uniformly distributed on seed. Seed should be uniformly blue, dry and free flowing with minimal traces of product left on the walls of the jar. Treat as close to seeding as practical. Do not store treated seed of these crops.

Under high flea-beetle pressure a foliar insecticide may be required. Check crop daily after emergence. READ THE ENTIRE PRODUCT LABEL BEFORE USING.

Hot Water Seed Treatment

Place seed in a cheesecloth of ample size, wet seed and bag with warm water. Soak seed of cabbage, brussels sprouts, pepper, spinach, tomato and eggplant for 25 minutes in water maintained at 50°C; cauliflower, kohlrabi, kale and summer turnip for 15 minutes at 50°C; celery for 30 minutes at 48°C, rutabaga for 20 minutes at 50°C. Then spread seeds out to dry on clean cheesecloth. USE AN ACCURATE THERMOMETER. Stir the water and bags of seed constantly to secure a uniform temperature within the bag. Before sowing, treat and dry seed with a seed protectant.

LIST OF INSECTICIDES/FUNGICIDES TRADE NAMES, ACTIVE INGREDIENT, MANUFACTURER AND CHEMICAL CLASSIFICATION

The class of chemical to which a pesticide belongs and its mode of action is designated as follows:

Chemical Classification		Mode of Action	
C	carbamate	C	contact
I	inorganic	S	stomach
OP	organophosphate	Sy	systemic
D	Dithiocarbamate	F	fumigant
OC	organochlorine	I	ingestion
OH	organohalogen		
N	dinitro		
T	triazine		
U	methyl urea		
M	miscellaneous		
#	designates a very toxic pesticide		

Insecticides/Fungicides

Trade Name	Active Ingredient	Manufacturer	Chemical Class	Mode of Action
Ambush	permethrin	Chipman Inc.	M	C,S
		Chemagro Ltd.		
Basudin	diazinon	Ciba Geigy	OP	C,S
Belmark	fenvalerate	Ciba Geigy	M	C,S
Benlate (fungicide)	benomyl	Dupont	M	
Birlane #	chlorfenvinphos	Stafford Chemical	OP	C
		Ciba Geigy		
Botran (fungicide)	dichloran	Tuco Products Co.		OH
Bravo (fungicide)	chlorothalonil	Chipman Inc.		OC
Captan (fungicide)	captan	Later Chemicals		M
Copper-Fixed (fungicide)	copper oxychloride			I
Counter	terbufos	Cyanamid	OP	Sy
Cygon	dimethoate	Cyanamid	OP	C,S,Sy
		Chipman Inc.		
Cythion	malathion	Cyanamid		
Dasanit	fensulfothion	Chemagro Ltd.		
Decis	deltamethrin	Hoechst	M	C,S
Diazinon	diazinon	Ciba Geigy	OP	C,S
Dibrom	naled	Chevron Chemical	OP	C,S
Difolaton (fungicide)	captafol	Chevron Chemical	M	
Dipel	Bacillus thuringiensis	Abbott Lab.	M	S
Di-System #	disulfoton	Chemagro	OP	Sy
Diathane M-22 (fungicide)	maneb	Dupont	D	
Dithane M-45 (fungicide)	mancozeb	Rohm & Haas	D	
Dithane Z-78 (fungicide)	zineb	Rohm & Haas	D	
Dyfonate	fonofos	Chipman		
Dylox	trichlorfon	Chemagro	OP	C,I
Dyrene (fungicide)	anilazine	Chemagro Ltd.	M	
Furadan #	carbofuran	Chemagro Ltd.	C	C,S,Sy
Guthion #	azinphos-methyl	Chemagro Ltd.	OP	C,S
Karathane (fungicide)	dinocap	Rohm & Haas	N	
Kelthane (miticide)	dicofol	Rohm & Haas		
Lagon	dimethoate	United Agri Products	OP	C,S,Sy
Lannate #	methomyl	Dupont	C	C,S,Sy
Lindane	lindane	May & Baker, Later		
Lorsban	chlorpyrifos	Dow Chemical	OP	C,S
Malathion	malathion	Cyanamid	OP	C,S
Mantox	maneb	Dupont		
Manzate-D (fungicide)	maneb	Dupont	D	
Manzate-200 (fungicide)	mancozeb	Dupont	D	
Mertect	triabendazole	Chipman		

Insecticides/Fungicides (continued)

Trade Name	Active Ingredient	Manufacturer	Chemical Class	Mode of Action
Metasystox-R #	oxydemeton-methyl	Chemagro Ltd.	OP	C,Sy
Methoxychlor	methoxychlor	Dupont	OC	C,S
Monitor #	methamidophos	Chevron Chemical	OP	C,S,Sy
Parathion	parathion	Cyanamid	OP	C,S
Phosdrin #	mevinphos	Ciba Geigy	OP	C,Sy
Pirimor	perimicarb	Chipman Inc.	C	C,F
Polyram (fungicide)	metiram	BASF	D	
Pounce	permethrin	Chipman Inc. Chemagro Ltd.	M	C,S
Pro-Gro	carbathiin-thiram	Uniroyal		
Ridomil MZ (fungicide)	metalaxyl + mancozeb	Ciba Geigy		
Rotenone	rotenone	Wilson's Lab.	M	C,S
Rovral	iprodione	May & Baker		
Sevin	carbaryl	May & Baker	C	C,S
Supracide	methidathion	Ciba Geigy	OP	C,I
Sys-Tem #	dimethoate	Cyanamid, Chipman	OP	
Systox	demeton	Chemagro Ltd.	OP	C,Sy
Terraclor	quintozene	Uniroyal		
Thiodan #	endosulfan	Chipman Inc. Hoechst	OC	C,S
Thiram	thiram	Uniroyal		
Thuricide	Bacillus thuringiensis	Sandoz Inc.	M	S
Vidate	oxanyl	Dupont		
Zineb	zineb	May & Baker		

SPRAY EQUIPMENT

Spray Nozzles

The function of spray nozzle tips is to break up the liquid pesticide into spray droplets, form the spray pattern and propel the spray droplets in the proper direction. Spray drift can be minimized by selecting nozzels that produce the largest droplet size while providing adequate coverage of the target at the intended application rate and pressure.

Nozzle tips are available in brass, aluminum, nylon, stainless steel, hardened stainless steel (HSS) and ceramic materials. Brass tips have a low initial cost; however, they wear rapidly if wettable powder pesticides are sprayed. Nozzles made of nylon, stainless steel and HSS are most commonly used. Plugged nozzle tips should be cleaned with a soft bristled brush or a toothpick. For nylon nozzle tips, use only a soft brush since a toothpick can damage the orifice. Worn nozzle tips may have a higher spray output or uneven spray patterns and should be replaced.

There are four main types of nozzle tips available. Their spray pattern characteristics and main uses are as follows:

Nozzle Type	Spray Pattern Characteristics	Main Use
flat fan	uniform when boom is at proper height; best for broadcast spraying	herbicides or insecticides
"even" spray	not uniform for broadcast spraying; good for band spraying	herbicides
solid or hollow cone	not uniform when used on a boom; best for directed spraying	insecticides and fungicides
flooding fan	not as uniform as flat fan nozzle, less drift occurs	liquid fertilizer and some herbicides
off-centre fan	not as uniform as flat fan nozzle; useful to extend coverage on headlands and fences where boom cannot reach	herbicides application for special situations

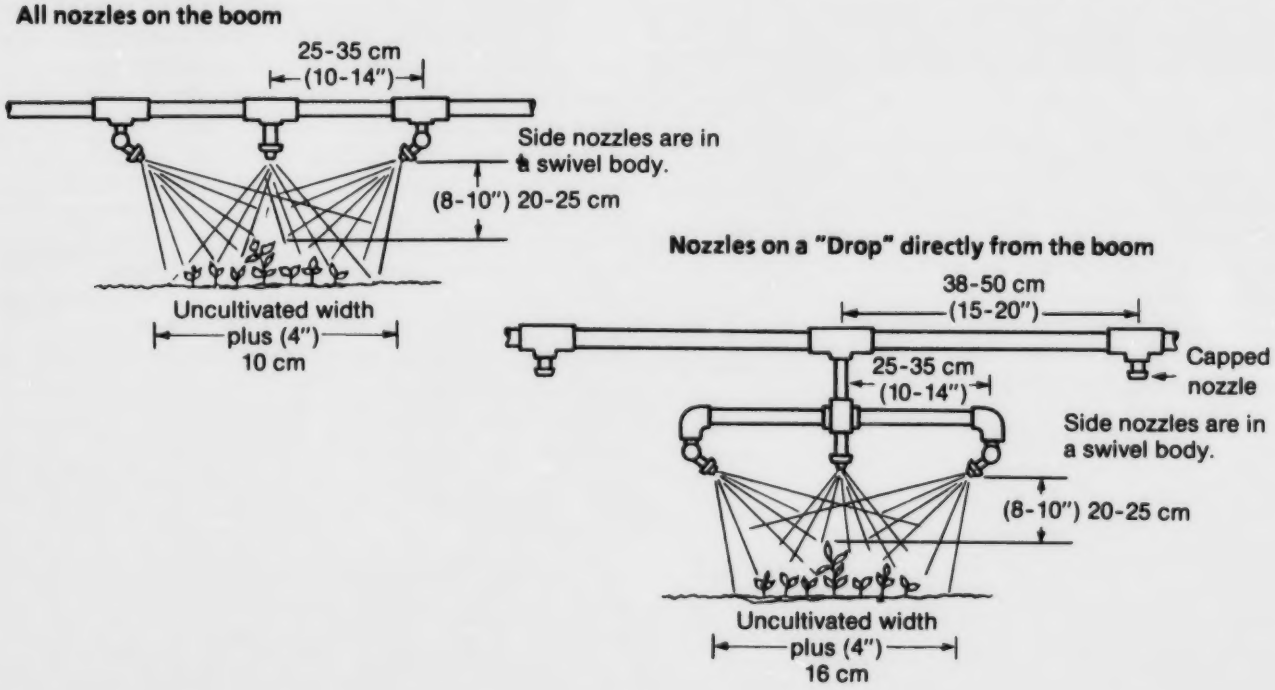
Flat fan nozzles can produce spray angles of 65°, 80°, and 110°. Nozzle tips with larger spray angles must be placed lower to the soil or crop to reduce the risk of spray drift.

The selection of nozzle tips will also depend upon the desired spray volume output and droplet size. For a number of herbicides, small droplet sizes with liquid spray volumes of 20 to 40 L/ac are required, whereas for others the recommended spray volume can range up to 445 L/ac. Since herbicide efficacy is affected by spray volume, growers should use proper sized nozzle tips.

For more details on nozzle tips and information on pumps, booms, spray overlap, controlled droplet applicators and sprayers in general, consult "Guide to Crop Protection in Alberta, Part III Pesticide Application Equipment", Agdex 744-5. Copies are available from the nearest district agriculturist office.

Band Spraying (Drenching)

Band spraying can be done with one, two or three nozzles per row. One nozzle per row may be used when the plants are small, but more nozzles and higher spray volumes are required as the plants grow or if more thorough spray coverage is needed. An even spray nozzle or a hollow cone nozzle should be



used for band spraying. Even spray nozzles are generally preferred for herbicides and hollow cone nozzles for drenching with insecticides.

Calculating the application rates for band spraying can be confusing. If one considers the concepts total acre (whole area of the field) and treatment acre (area actually treated in the band). To calculate the amount of pesticide to be used, multiply the broadcast rate per acre times the fraction

$$\frac{\text{band width}}{\text{row width}}$$

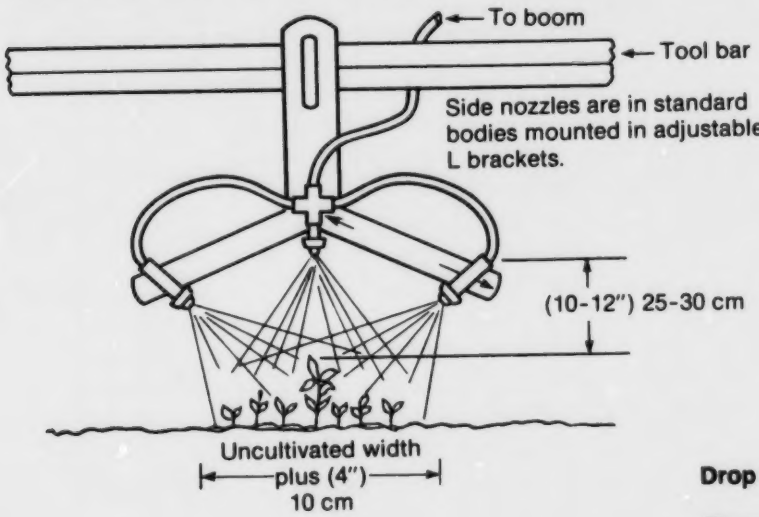
For example, 6 L/ac to be applied to a 10 cm band with 60 cm row spacing. Then 6 L/ac x 10/60 = 1 L/ac is required for each acre treated in 10 cm bands with 60 cm row spacings.

Several band spraying arrangements are available.

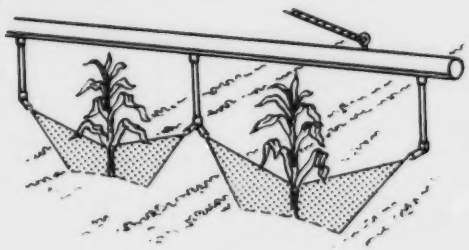
Drop Nozzles

Drop nozzles are recommended for certain pesticide applications, for example 2,4-D amine must be applied when corn exceeds 15 cm in height. Drop pipes can be connected to the spray boom by replacing nozzle outlets. The drop pipe should have a double survival nozzle housing so that two nozzle tips per drop pipe can be installed. This provides two nozzles for each crop row on either side of the drop pipe.

Nozzles on a "Drop" independent of the boom



Drop Nozzles



Compatibility chart for spray chemicals

	Ambush	Basudin (diazinon)	Benlate, Easout	Birlane	Botran	Bravo	Captan, Difolatan	Coppers (fixed)	Cygon, Rogor, Dimethoate or Lagon	Dasanit	Dibrom, Phosdrin	Dipel, Thuricide	DI - Syston	Dithane M-22, M-45	Du-ter	Dyfonate	Ethion	Furadan	Guthion	Kelthane	Lannate	Malathion	Manzate-D 200	Metasystox-R	Methoxychlor	Monitor	Parathion	Pirimor	Polyram, Zineb, dithane Z-78	Sevin	Systox	Thiodan
Ambush		0		0	0			0	0	0	0	0	0		0	0	0	0	0	0	0	0		0	0	0	0			0	0	0
Basudin (diazinon)	0			0				D		0	0		0			0		0			0	0		0		0		0			0	
Benlate, Easout				0				C																		0	C					
Birlane	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Botran	0		0	0			0	X	0	0	0		0	WP	0	0	WP	0	0	WP	C	WP	WP	WP	WP	0	WP	0	WP		WP	
Bravo				0														0		0	C					0		C				
Captan, Difolatan				0	0			0		0			0	0		0	WP	0		WP		WP	0	WP	WP	0	WP		0		WP	WP
Coppers (fixed)	0	D	C	0	X		0			0			0	D		0	0	0					D			0		0	D	X		
Cygon, Rogor, Dimethoate or Lagon	0			0	0					0								0			0					0		0				
Dasanit	0	0		0	0		0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dibrom, Phosdrin	0	0	X	0	0					0								0				0		0		0		0			0	
Dipel, Thuricide	0			0	0					0			0													0						
DI - Syston	0	0		0	0		0	0		0		0		0	0			0		0	0	0	0	0	0	0		0	0	0	0	
Dithane M-22, M-45				0	WP		0	D		0			0			0	0	0					0		WP	0		0	0			
Du-ter	0	WP		0	0				0				0					0	0							0				WP		0
Dyfonate	0	0		0	0		0	0		0				0				0		0	0	0	0	0	0	0	0	0	0	0	0	
Ethion	0			0	WP		WP	0		0				0				0		0		0	0	0	0	0	0	0	0	0	0	
Furadan	0	0		0	0		0	0	0	0	0		0	0		0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Guthion	0			0	0					0								0								0						
Kelthane	0			0	WP	0	WP			0			0			0	0	0								0		0				
Lannate	0	0		0	C	C			0	0			0			0		0								0						
Malathion	0	0		0	WP		WP			0	0		0			0	0	0								0		0				
Manzate-D 200				0	WP		0	D		0			0	0		0	0	0							WP	0			0			
Metasystox-R	0	0		0	WP		WP			0	0		0			0	0	0								0				0		
Methoxychlor	0			0	WP		WP			0			0	WP		0	0	0					WP			0		0	WP			
Monitor	0	0	0	0	0	0	0	0	0	0	0		0	0		0	0	0	0	0	0	0	0	0			0		0	0	0	0
Parathion	0		C	0	WP		WP			0						0	0	0								0		0				
Pirimor		0		0	0	C		0	0	0	0		0		0	0	0	0		0		0			0							
Polyram, Zineb, dithane Z-78				0	WP		0	D		0			0	0		0	0	0					0		WP	0						
Sevin	0			0				X		0			0			0	0	0								0						
Systox	0	0		0	WP		WP			0	0		0			0	0	0						0		0						
Thiodan	0			0			WP			0								0								0						

□ = Generally compatable
X = Incompatible
0 = Not usually mixed or compatibility not known

WP = Use wettable powder forms
D = Decomposes on standing, use immediately
C = Generally satisfactory but occasionally damage occurs

This chart applies only to the use of two material combinations. When three or more materials are mixed or when a wettable powder and a liquid formulation are mixed, incompatibility may develop. In all cases follow directions on the label.

SPREADERS and STICKERS (SURFACTANTS) - Usually surfactants are incorporated into pesticide formulations by the manufacturer. Unless otherwise specified on the pesticide label, do not add surfactants.

Minimum number of days required between last pesticide application and harvest

PESTICIDES	CROPS																					
	Asparagus	Beans	Beets	Broccoli	Brussels Sprouts	Cabbage	Carrots	Cauliflower	Celery	Corn	Cucumber	Dill	Eggplant	Lettuce	Onions	Parsnips	Peas	Peppers	Potatoes	Radishes	Rutebagas	Spinach	Tomatoes
Ambush		7		7	3	3		3		1									1	2			
Basudin		7	14	5	14	7	10	5						10	10	10		5	14	10	14	10	1
Belmark				14	14	14		14											7				
Benlate		14									0												0
Birlane				40	40	40		40											7		40		
Botran		2																					
Bravo				7	7	7	1	7	7		1								7				1
Captan																							2
Coppers (fixed)		1	1	1	1	1	1	1	1		1		1					1	1			1	1
Cygon or Systems or Dimethoate or Lagon		7		4	21	4		4						7			3	3	7			7	7
Desanit				40	40	40		40											100		40		
Decis				7		7													23				
Diazinon		7	14	5	14	7	10	5						10	10	10		5	14	10	14	10	1
Dibrom		4		4	4	4		4	4					4	4		4		4			4	4
Difolatan															1				1				1
Dipel, Thuricide				0	0	0		0															
Di - Syston			50	42	30	42		30		40-100			90				50	90	90				30
Dithane M-22									14		5			7	10+				1				3
Dithane M-45									7		5				10+				1				1
Dithane Z-78				7	7	7		7	14		5			10	7				1				5
Dyrene									7‡		1								1				
Furadan										7									7		40		
Guthion																			7		35	14	2
Karathane										30													
Kelthane		7									2								2				2
Lannate				7	7	7		7		3				7			1‡		3				1
Lorsban				32	32	32	60	32	70	70	60				60			40	7				7
Malathion, Cythion	1	3	7	3	7	7	7	7	7		3	7		14	3		3	3	3	7			3
Mantox														7	10				1				
Manzate-D									14		5			7	10+				1				3
Manzate 200									7		5				10+				1				1
Metasystox-R				21	24	24		24			14								7		14		
Methoxychlor		7	7	14	14	3		7					1	14			7	1	7	7	7	14	1
Monitor				14	14	7		7						14					14				
Parathion				7	15	7	15	7	15					5***	15		10*					7	
Phosdrin		1		2	3	2	3	3	3		1			3	1		1		1		1	3	1
Pirimor	7									3				7			6	3	7				
Polyram																			1				
Ridomil MZ																			7				
Rotenone	0	0		0	0	0		0		0	0			0			0						0
Sevin	1	3	14	3	3	3	1	3	3	1	3		1	3-14		7	3	1	7	7	14	7-14	1
Systox		2		21	21	21		21	28				7	21			21	3	21				3
Thiodan		2		7	7	7		7	14	50	2		2	14			7	2	1		45	14	2
Zineb				7	7	7		7	14		5			10	7				1				5

* If pea vines are to be fed to livestock fresh or as hay or silage, do not treat within 15 days of harvest.

** If lannate is used, do not feed pea vines to livestock

*** 21 days for leaf lettuce

‡ Not registered for use on green onions

○ No time restriction

□ Not recommended or not registered

Compatibility chart for spray chemicals

	Ambush	Basudin (diazinon)	Benlate, Easout	Birlane	Botran	Bravo	Captan, Difolatan	Coppers (fixed)	Cygon, Rogor, Dimethoate or Lagon	Dasanit	Dibrom, Phosdrin	Dipel, Thuricide	Di - Syston	Dithane M-22, M-45	Du-ter	Dyfonate	Ethion	Furadan	Guthion	Kelthane	Lannate	Malathion	Manzate-D 200	Metasystox-R	Methoxychlor	Monitor	Parathion	Pirimor	Polyram, Zineb, dithane Z-78	Sevin	Systox	Thiodan
Ambush		0		0	0			0	0	0	0	0	0		0	0	0	0	0	0	0	0		0	0	0	0			0	0	0
Basudin (diazinon)	0			0				D		0	0		0			0		0			0	0		0		0	0				0	
Benlate, Easout				0				C																		0	C					
Birlane	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Botran	0		0	0			0	X	0	0	0		0	WP	0	0	WP	0	0	WP	C	WP	WP	WP	WP	0	WP	0	WP		WP	
Bravo				0														0		0	C					0		C				
Captan, Difolatan				0	0			0		0			0	0		0	WP	0		WP		WP	0	WP	WP	0	WP		0		WP	WP
Coppers (fixed)	0	D	C	0	X		0			0			0	D		0	0	0					D			0		0	D	X		
Cygon, Rogor, Dimethoate or Lagon	0			0	0					0								0			0					0		0				
Dasanit	0	0		0	0		0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dibrom, Phosdrin	0	0	X	0	0					0								0				0		0		0		0			0	
Dipel, Thuricide	0			0	0					0			0													0						
Di - Syston	0	0		0	0		0	0		0		0		0	0			0		0	0	0	0	0	0	0		0	0	0	0	
Dithane M-22, M-45				0	WP		0	D		0			0			0	0	0					0		WP	0		0	0			
Du-ter	0	WP		0	0				0				0					0	0							0				WP		0
Dyfonate	0	0		0	0		0	0		0				0				0		0	0	0	0	0	0	0	0	0	0	0	0	
Ethion	0			0	WP		WP	0		0				0				0		0		0	0	0	0	0	0	0	0	0	0	
Furadan	0	0		0	0		0	0	0	0	0		0	0		0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Guthion	0			0	0					0								0								0						
Kelthane	0			0	WP	0	WP			0			0			0	0	0								0		0				
Lannate	0	0		0	C	C			0	0			0			0		0								0						
Malathion	0	0		0	WP		WP			0	0		0			0	0	0								0		0				
Manzate-D 200				0	WP		0	D		0			0	0		0	0	0							WP	0			0			
Metasystox-R	0	0		0	WP		WP			0	0		0			0	0	0								0				0		
Methoxychlor	0			0	WP		WP			0			0	WP		0	0	0					WP			0		0	WP			
Monitor	0	0	0	0	0	0	0	0	0	0	0		0	0		0	0	0	0	0	0	0	0	0			0		0	0	0	0
Parathion	0		C	0	WP		WP			0						0	0	0								0		0				
Pirimor		0		0	0	C		0	0	0	0		0		0	0	0	0		0		0			0		0					
Polyram, Zineb, dithane Z-78				0	WP		0	D		0			0	0		0	0	0					0		WP	0						
Sevin	0			0				X		0			0			0	0	0								0						
Systox	0	0		0	WP		WP			0	0		0			0	0	0						0		0						
Thiodan	0			0			WP			0								0								0						

□ = Generally compatable
X = Incompatible
0 = Not usually mixed or compatibility not known
WP = Use wettable powder forms
D = Decomposes on standing, use immediately
C = Generally satisfactory but occasionally damage occurs

This chart applies only to the use of two material combinations. When three or more materials are mixed or when a wettable powder and a liquid formulation are mixed, incompatibility may develop. In all cases follow directions on the label.

SPREADERS and STICKERS (SURFACTANTS) - Usually surfactants are incorporated into pesticide formulations by the manufacturer. Unless otherwise specified on the pesticide label, do not add surfactants.

Minimum number of days required between last pesticide application and harvest

PESTICIDES	CROPS																					
	Asparagus	Beans	Beets	Broccoli	Brussels Sprouts	Cabbage	Carrots	Cauliflower	Celery	Corn	Cucumber	Dill	Eggplant	Lettuce	Onions	Parsnips	Peas	Peppers	Potatoes	Radishes	Rutabagas	Spinach	Tomatoes
Ambush		7		7	3	3		3		1									1	2			
Basudin		7	14	5	14	7	10	5						10	10	10		5	14	10	14	10	1
Belmark				14	14	14		14											7				
Benlate		14									0												0
Birlane				40	40	40		40											7		40		
Botran		2																					
Bravo				7	7	7	1	7	7		1								7				1
Captan																							2
Coppers (fixed)		1	1	1	1	1	1	1	1		1		1					1	1			1	1
Cygon or Systems or Dimethoate or Lagon		7		4	21	4		4						7			3	3	7			7	7
Dasanit				40	40	40		40											100		40		
Decis				7		7													23				
Diazinon		7	14	5	14	7	10	5						10	10	10		5	14	10	14	10	1
Dibrom		4		4	4	4		4	4					4	4		4		4			4	4
Difolatan															1				1				1
Dipel, Thuricide				0	0	0		0															
Di - Syston			50	42	30	42		30		40-100			90				50	90	90				30
Dithane M-22									14		5			7	10+				1				3
Dithane M-45									7		5				10+				1				1
Dithane Z-78				7	7	7		7	14		5			10	7				1				5
Dyrene									7‡		1								1				
Furadan										7									7		40		
Guthion																			7		35	14	2
Karathane										30													
Kelthane		7									2							2					2
Lannate				7	7	7		7		3				7			1‡		3				1
Lorsban				32	32	32	60	32	70	70	60				60			40	7				7
Malathion, Cythion	1	3	7	3	7	7	7	7	7		3	7		14	3		3	3	3	7			3
Mantox														7	10				1				
Manzate-D									14		5			7	10+				1				3
Manzate 200									7		5				10+				1				1
Metasystox-R				21	24	24		24			14								7		14		
Methoxychlor		7	7	14	14	3		7					1	14			7	1	7	7	7	14	1
Monitor				14	14	7		7						14					14				
Parathion				7	15	7	15	7	15					5***	15		10*					7	
Phosdrin		1		2	3	2	3	3	3		1			3	1		1		1		1	3	1
Pirimor	7									3				7			6	3	7				
Polyram																			1				
Ridomil MZ																			7				
Rotenone	0	0		0	0	0		0		0	0			0			0						0
Sevin	1	3	14	3	3	3	1	3	3	1	3		1	3-14		7	3	1	7	7	14	7-14	1
Systox		2		21	21	21		21	28				7	21			21	3	21				3
Thiodan		2		7	7	7		7	14	50	2		2	14			7	2	1		45	14	2
Zineb				7	7	7		7	14		5			10	7				1				5

* If pea vines are to be fed to livestock fresh or as hay or silage, do not treat within 15 days of harvest.

** If lannate is used, do not feed pea vines to livestock

*** 21 days for leaf lettuce

‡ Not registered for use on green onions

○ No time restriction

□ Not recommended or not registered

Table 7.

Herbicides for Use in Vegetable Crops

HERBICIDES	CROPS: Asparagus	Beans, Snap	Beets, Red	Broccoli	Brussels Sprouts	Cabbage, Cauliflower	Carrots	Celery	Corn, Sweet	Cucumbers	Lettuce	Onions, Dry Bulb	Parsnips	Peas	Potatoes	Rutabagas	Squash, Pumkin	Tomatoes	Barnyard Grass	Barley, Volunteer	Foxtail, Green	Oats, Wild	Wheat, Volunteer	Quackgrass	Bindweed, Field	Bluebur	Buckwheat, Tartary	Buckwheat, Wild	Canola, Volunteer	Catchfly, Night Flowering	Chamomile, Scentless
Afolan F/Lorox L	0						0	0					0		0				R		R							R			
Agricultural Weed Killer No. 1							0	0					0																		
Alanap-3										0											R										
Amiben	0																0		R		R										
Amitrol-T	0																														
Atrizine									0										R		S	R						R			
Basagran		0							0					0											S				R		
Bladex									0										R		R							R			
Buctril M									0																	R	R	R	R	R	R
CIPC											0	0																			
Devrinol																		0	R												
Dual									0						0				R		R										
Edge														0					R	S	R	R	R				R				
Eptam		0													0	0			R	R	R	R	R								
Eptam + Sencor or Lexone															0				R	R	R	R	R				R		R	R	
Eradicane 8-E									0										R	R	R	R	R								
Excel				0		0						0			0				R	R	R										
Fusilade												0			0			0	R	R	R	R	R	S							
Goal									0			0																R			
Gramoxone-Stale Seedbed		0	0	0		0	0			0		0		0	0	0															
Hoe-Grass 284		0					0					0		0	0				R		R	R									
Kil-Mor									0																S		R	R			
Laddock									0																						
MCPA-Sodium, MCPA Amine	0													0											S	R	S	S			
Torch									0																		R	R			R
Poast		0										0			0		0		R	R	R	R	R	S							
Prefar										0									R		R										
Primextra									0										R		R							R			
Princep Nine-T/Simadex/ Simadex 80WP/Simazine 80W	0																		R			R						R			
Pyramin			0																									R			
Ro-Neet-7 2E			0																R		R	R									
Sencor/Lexone															0												R		R	R	
Surpass 8-E									0										R		R										
Sutan +									0										R		R										
Treflan, Rival		0		0	0	0	0						0		0		0		R		R	R						R			
Tropotox plus													0											S					R		
2, 4-D Amine	0								0																	R	S	S			

0 - Herbicide registered for crop
R - Controlled (registered)
S - Suppression

WEEDS

HERBICIDES	Chickweed	Cocklebur	Corn Spurry	Cow Cockle	Flixweed	Goosefoot	Groundsel, Common	Hemp-nettle	Henbit	Knotweed, Prostrate	Kochia	Lamb's-quarters	Lettuce, Prickly	Mallow, Round-leaved	Mustard, Tumble	Mustard, Wild	Mustard, Wormseed	Nightshade spp.	Pigweed, Prostrate	Pigweed, Redroot	Pigweed, Tumble	Purslane, Common	Ragweed, Common	Russian Thistle	Shepherd's-purse	Smartweeds, Annual	Sow Thistle, Annual	Sow Thistle, Perennial	Stinkweed	Sunflower, Volunteer	Thistle, Canada
Afolan F/Lorox L	R					R				R		R					R		R	R		R	R		R	R	R		R		
Agricultural Weed Killer No. 1												R								R		R									
Alanap-3	R	R										R								R		R	R								
Amiben	R											R				R			R	R			R			R			•		
Amitrol-T	Controls most perennials and annuals.																														
Atrizine												R				R	R			R		R	R			R					
Basagran	R	R	R				R					R				R		R		S		R	R	R	R	R			R		S
Bladex						R				R	R	R				R	R	R		R		R	R	R	R	R					
Buctril M		R		R	R		R				R	R				R	R	R		R			R	R	R	R			R	R	
CIPC	R																					R				R					
Devrinol												R							R	R		R	S								
Dual																		R													
Edge	R		R	R				S			R	R						S	R	R		R		S		S					
Eptam	R		R						R			R						R	R	R	R	R									
Eptam + Sencor or Lexone	R		R				R	R	R			R				R	R	R	R	R	R	R		R	R	R			R		
Eradicane 8-E	R		R						R			R						R	R	R	R	R									
Excel																															
Fusilade																															
Goal						R						R						R		R		R									
Gramoxone-Stale Seedbed	Controls annual weed seedlings and too growth of perennial weeds.																														
Hoe-Grass 284																															
Kil-Mor		R	R	R	R					R		R		S		R	R		R	R			R	R	R	R	R		R		S
Laddock	R	R	R				R	S				R				R		R		R		R	R	R		R					
MCPA-Sodium, MCPA Amine		R			R	R					R	R	R		R	R	R			R	R		R		R	S	S	S	R	R	S
Torch				R			R				R	R				R		R		R			R	R		R			R		
Poast																															
Prefar																															
Primextra												R				R		R	R	R		R	R			R					
Princep Nine-T/Simadex/ Simadex 80WP/Simazine 80W												R										R	R			R					
Pyramin	R					R				R		R				R	R	R	R	R		R	R		R	R			R		
Ro-Neet-7 2E									R			R						R		R		R									
Sencor/Lexone	R		R				R	R	R			R				R	R			R				R	R	R			R		
Surpass 8-E												R								R		R									
Sutan +																															
Treflan, Rival	R			R						R		R								R		R		R							
Tropotox plus								S				R				R	R			R			R		R		S	S	R		S
2, 4-D Amine		R			R	R					R	R	R		R	R	R		R	R	R		R		R		S	S	R	R	S

0 - Herbicide registered for crop
R - Controlled (registered)
S - Suppression

STORAGE AND SHELF LIFE OF PESTICIDES

Most pesticides are designed to last for two years or longer when properly stored by the user. Proper storage involves cool, dry conditions. Wettable powders stored at cool temperatures and low humidities will be stable for at least this period of time. Bags should be tightly sealed during storage. Liquid formulations generally do not last as long as powders, but if kept sealed and away from temperature extremes, should last for two years. It is a good idea to observe this two year period and purchase only sufficient material to use within this time.

The following list provides further information on storage of some specific pesticides.

Pesticide	Shelf Life	Minimum Storage Temperature	Comments
Insecticides			
Carbaryl	several years	0°C	Flowable formulations may settle out.
Diazinon	5-7 years	-18°C	Keep liquids tightly sealed; granulars and powders dry.
Di-Syston#	2 years	-18°C	-
Guthion#	2 years	0°C	-
Malathion	indefinite	-18°C	-
Metasystox R#	2 years	-18°C	-
Methoxychlor	indefinite	0°C	-
Fungicides		(spray concentrated)	
Benomyl	2 years	*	Keep dry and tightly sealed.
Captan	3 years	5°C	-
Herbicides		(flowable)	
Dacthal	at least 2 years	*	-
Roundup	at least 2 years	0°C	-
Kerb	at least 2 years	*	-
Gramoxone#	indefinite	0°C	very stable
Treflan	3 years	*	store below 27°C

*Most dry formulations have no minimum storage temperature.

SECTION 4
SOIL MANAGEMENT AND FERTILITY

INTRODUCTION

Testing of soils annually after October 1 should be a part of good management in vegetable production. Although there are many private soil testing facilities that will conduct the actual analysis, the report on findings generally covers the major nutrients, soil reaction (pH), soil salinity and if requested, soil organic matter. Micronutrient testing usually is not routine and must be specifically requested.

SOIL NUTRIENTS MEASURED IN A SOIL TEST

The plant nutrients that are likely to be lacking in Alberta soils are nitrogen, phosphorus, and to a lesser extent sulphur and potassium. Few soils are so deficient in one or more of these nutrients that obvious deficiency symptoms develop in the plants. Deficiencies of micronutrients have rarely been encountered or documented.

Fertilizer requirements will vary from field to field and from year to year. Therefore, soil tests should be used as a tool to determine the kind and rate of fertilizer to apply. The general recommendation given for each crop should only be used as a guide when a soil test is not available. The following is a description of the various soil nutrients and their behavior.

Nitrogen

The nitrogen test measures available nitrogen (nitrate) in the soil at the time of sampling. To assess the nitrogen status of the soil, soil samples should be taken in late fall or early spring. Nitrate nitrogen moves readily with soil moisture. Therefore, on irrigated soils in particular, soil samples should be taken to a depth of 0.5 metre (2 ft) to accurately assess the level of available nitrogen. (See the soil sampling guide in the soil testing kits.)

In addition to the available nitrogen in the soil at planting, available nitrogen is released by the soil during the growing season. Soils that have recently been manured or broken from a legume or grass-legume mixture will release larger amounts of nitrogen during the growing season. This information must be supplied with the soil samples so that nitrogen fertilizer recommendations can be adjusted accordingly.

Phosphorus

The level of available phosphorus in a particular field does not change dramatically from year to year unless very high rates of phosphate fertilizer or manure are applied. A soil test for phosphorus can be used as a guide to phosphate fertilizer requirements for 2 to 3 years. Periodic evaluation of the soil phosphorus level will provide a useful guide to changes in this nutrient over a period of time.

Potassium

Soils in southern Alberta are not generally deficient in potassium, but some soil types in west central Alberta and northeastern Alberta are often moderately low in available potassium. Most soils in southern Alberta are high in available potassium, but some sandy soils may be deficient for potatoes, which have a very high potassium requirement. A soil test should be used to identify a need for the use of potassium fertilizers in a cropping program. Periodic soil tests will provide an assessment of changes in the potassium level in the soil over time.

Sulphur

Some soils in central, northern and western Alberta are deficient in sulphur. The test for sulphur is done in areas where it is known to be deficient and will be done in other areas upon request.

SOIL REACTION (pH)

Soil reaction or pH, which is given in a soil test report, is a measure of the acidity or alkalinity (sweetness) of a soil. The terms alkaline and alkali should not be confused. Alkali is an old term used to describe soils which are high in sodium salts.

Soils with pH's of 6.5 to 7.5 are considered neutral and most vegetables grow well in this range. Soils of pH 6.0 or less are considered to be acid. There are some acid soils in central and west central Alberta and the Peace River area that would benefit from liming. Generally, there are very few acid soils in southern Alberta, and liming is not required. Soils whose pH range is from 7.8 to 8.5 or higher are said to be alkaline. These soils can have associated salt problems and require special attention.

SOIL SALINITY

Soil salinity, often incorrectly referred to as alkali, may be a problem in many parts of Alberta. Saline soils are often formed in areas where there is an excess of water that rises to the surface and evaporates leaving salts accumulated on the soil surface. The use of irrigation water that has a high salt content may cause soil salinity to develop. Saline soils crust easily and are difficult to till if they are too wet or dry. Severe soil salinity will cause bare white spots in a field, but moderate levels of soil salinity cause poor growth of salt sensitive crops. Differences in tolerance to salinity exist between various crops and in some cases varieties of the same crop. Soil salinity is measured by electrical conductivity. The soil test also reports the levels of sulphates and sodium because they can cause salinity problems. Some crops, such as beets, are sensitive in the seedling stage but become tolerant later, and others like corn are salt tolerant in the seedling stage and become sensitive later.

Crops growing in a saline area show reduced growth and may have leaves that are darker colored than normal. Soil salinity will cause a burning on the edge of the leaves, and the plants may wilt when the soil is still moist.

It is preferable to grow high value vegetable crops on non-saline soils. If saline soils are used, only those crops that are tolerant to the level of salinity present in the soil should be grown. It is possible to reclaim saline soils by subsurface drainage, but this is costly. Consult an irrigation specialist before proceeding.

Fertilizer are salts and, if they accumulate in the soil in excess amounts, can interfere with germination and growth just as natural soil salts do. Therefore, high amounts of soluble, granular fertilizers (nitrogenous) should not be placed with or near seeds.

SOIL ORGANIC MATTER

Organic matter is a general term applied to plant and animal tissue in various stages of decomposition. Crude plant material such as roots, leaves, vines, stems and straw do not become organic matter until they start to decompose. As organic matter decomposes, it performs many important functions in the soil and contributes to plant growth. Functions of organic matter include:

1) serves as a food source for growth and reproduction of soil micro-organisms
2) source of both macro- and micronutrients for growing plants
3) release of chemicals during decomposition. Acids are formed, which in turn release plant nutrients from soil minerals
4) improves soil structure, aeration, water penetration and water holding capacity of the soil through both physical and chemical action.

Growing vegetables in rotation with grain and hay crops and applying manure to vegetable fields will maintain good soil structure and an adequate level of organic matter. When only vegetable crops are grown, soil compaction can occur because organic matter is rapidly broken down and very little is replaced. It is important to maintain the organic matter content of the soil used for vegetable production.

Organic matter levels are often given in a soil test report.

Salt Tolerance of Crops From The Late Seedling Stage Until Maturity

Sensitive (0-4 millisiemens/cm or mmhos/cm)	Moderately Sensitive (4-8 millisiemens/cm or mmhos/cm)	Moderately Tolerant (8-15 millisiemens/cm or mmhos/cm)
Bean	Broccoli	Beets
Carrots	Brussels sprouts	Spinach
Celery	Cabbage	Asparagus
Eggplant	Cauliflower	
Onion	Cucumber	
Peas	Lettuce	
	Pepper	
	Potatoes	
	Radish	
	Tomatoes	

MAINTAINING SOIL ORGANIC MATTER

A market garden or commercial vegetable operation should consider a program of cropping that will maintain or replenish soil organic matter. Such a program is more critical on brown and dark brown soils than on black soils.

Organic matter can be maintained or replenished in the soil by adding animal manures, crop residues or green manures.

When limited acreage results in intensive cropping, the application of manure may be the most practical alternative (see section on use of manures). Plowing down crop residues, such as grain stubble, is more feasible when vegetable growing is only one part of a large farming operation.

Green manures can be left to overwinter as a cover crop to prevent soil erosion and to collect snow. Spring wheat and oats seeded at about 45 kg/ac can be used for cover crops. A mixture of peas at 28 kg/ac and oats at 45 kg/ac or straight oats are good green manure crops that can be planted and plowed down the same year.

Fertilize green manure crops with 45-90 kg/ac of 16-20-0. Some of the nitrogen and phosphorus will be available for the following vegetable crop. If a green manure crop is left overwinter, broadcast the fertilizer planned for vegetable crops after plowing down the crop but prior to shallow cultivation. Additional nitrogen fertilizer at 40-65 kg/ac of 34-0-0 may be required to replace that used in the breakdown of the green manure crop.

Manure

Manures vary greatly in their content of nutrients. The kind of feed used, the volume and type of bedding used, the moisture content and the age and degree of rotting or drying can all modify the nutrient composition.

Source	Per Cent Moisture	Approximate Composition (lb/ton) N	P_2O_5	K_2O
Cattle	75	12	7	11
Poultry	65	22	20	10
Hog	87	11	6	9
Sheep	68	20	15	8

NOTE: When using manure, Tordon 202C treated grains fed to livestock will result in residue buildup that can cause serious growth checks on vegetables. Residues can also be introduced to the soil if using straw for bedding that has been sprayed with Tordon 202C.

The amount of nutrients in manure varies a great deal depending on: the type of animal, the type of feed, the feeding method, age of the manure and method of storage. Fresh manure has considerable nitrogen, but nitrogen can volatilize into the air or be leached out by rain. The nitrogen content in old manure may be very low. As a rough guide, a 4-6 t/ac application of pig, beef or dairy manure would add from 8-28 kg/ac of nitrogen, phosphorus, and potassium.

When using manures in combination with commercial fertilizers, reduce the amount of fertilizer nutrients by the amount of nutrients added in the manure. It is important to monitor the nutrient content of soil by soil testing.

Do not apply manure in the same year that potatoes and rutabagas are to be grown. Potatoes may become scabby and rutabagas uneven and cracked.

Fresh manure may contain large numbers of viable weed seeds that can infest clean land. This manure is usually suitable for spreading after it has been piled for 1 or 2 years. Feed lot manure can contain a high level of salts, which, if added to a soil already slightly saline, could further add to the soil salinity.

Manure should be applied in the fall and worked into the soil immediately to allow adequate mixing and breakdown before spring seeding, and to prevent loss of nitrogen to the air.

COMMERCIAL FERTILIZERS

Pricing Fertilizers

The Fertilizer Act requires that fertilizers be labelled according to their guaranteed analysis in terms of percentage by weight of nitrogen (N), phosphate (P_2O_5), and potash (K_2O). For example, 45 kg (100 lb) of 11-48-0 contains 5 kg (11 lb) of nitrogen (N), 22 kg (48 lb) of phosphate (P_2O_5), and 0 kg (0 lb) of potash K_2O). Fertilizer should be purchased on the basis of the price per kilogram (pound) of nutrient.

Nitrogen Fertilizer

Nitrogen Fertilizer Placement

Because nitrogen moves readily in moist soil, it does not have to be applied near the seed. However, surface application or shallow incorporation can result in reduced uptake if the seedbed remains dry during the early growing season. Nitrogen applied in a band at a depth of 11-15 cm (4-6 in.), (i.e. an anhydrous ammonia application), or drilled in with the seed may be more effective when the surface soil remains dry during the early growing season.

Excess nitrogen drilled with the seed can reduce germination and seedling emergence.

Time of Application

Nitrogen fertilizers can be applied in spring or late fall. Nitrogen applied in the fall has a greater opportunity to move deeper into the root zone and therefore may be more effective than nitrogen broadcast in the spring under dry conditions. Wet conditions that may occur in central and northern Alberta on fine textured and poorly drained soils can cause significant losses of applied nitrogen because of denitrification (loss of gaseous nitrogen). Therefore, fall application is not recommended on poorly drained areas where the soil remains saturated or flooded for an extended period in the spring. It is preferable to delay fall application of nitrogen until the soil temperature has declined to 0°C or less.

Nitrogen Fertilizer Sources

1) Ammonium nitrate (34-0-0):
   - contains nitrogen in both the ammonium and nitrate form
   - can be applied to foliage with minimal leaf scorching
   - subject to leaching losses on sandy soils
   - used with ammonium phosphate to make the common fertilizer grades 23-23-0 and 26-13-0.

2) Ammonium sulphate (21-0-0-24S):
   - 24% sulphur
   - used for direct application as both a nitrogen and sulphur source
   - used with ammonium phosphate to make 16-20-0
   - more acidifying than other nitrogen fertilizers and should not be used continuously on acid soils.

3) Urea (46-0-0)
   - highest analysis dry nitrogen fertilizer
   - used for direct application or combined with phosphate to make 27-27-0
   - not suitable for dry broadcast application to green leafy crops.
   - more subject to 'evaporation' when not incorporated into the soil. Significant losses can occur when urea is applied under warm dry conditions to sandy soils, and on alkaline soils (pH 7.5 or higher).

4) Anhydrous ammonia (82-0-0):
   - highest analysis nitrogen fertilizer
   - suitable for fall or spring application for annual crops
   - a narrow shank applicator with 40 cm (16 in.) spacing is commonly used to inject ammonia at a depth of 10-15 cm (4-6 in.). The soil must be worked sufficiently close behind the application shank to prevent escape of the ammonia gas.

CAUTION: Anhydrous ammonia is a pressurized gas.

5) Urea - Ammonium sulphate (34-0-0-11S):
   - contains 11% sulphur
   - supplies adequate sulphur when used as the nitrogen source on sulphur deficient soils.

6) Urea - Ammonium nitrate solutions (28-0-0 and 32-0-0):
   - losses from volatilization and immobilization may occur if sprayed on heavy trash cover
   - solutions lend themselves to uniform application and ease of handling.

7) Urea - Ammonium sulphate solution (20-0-0-5S):
   - contains 5% sulphur and will supply adequate sulphur when used as the nitrogen source on sulphur deficient soils.
   - comments under No. 6 also apply to 20-0-0-5S.

Phosphate Fertilizer

Phosphate fertilizer does not move readily in soil so it must be placed near the seedling roots to be most effective. For annual crops it should be drilled with or near the seed. On perennial crops like asparagus, a greater response may occur in the years following application than in the year of application. On soil very deficient in phosphorus, phosphate fertilizer should be applied and incorporated prior to seeding perennial crops.

Phosphate Fertilizer Sources

1) Monoammonium phosphate (11-48-0, 11-51-0, 11-54-0 and 11-55-0):
   - the most common phosphate fertilizer available
   - used for drill-in or hand application on annual crops, or may be broadcast
   - blended with nitrogen fertilizers to give various nitrogen phosphate fertilizers such as 16-20-0, 23-23-0, 27-27-0 and 26-13-0.

Common Commercial Fertilizer Formulations

Product	Nutrient Ratio	Primary Nutrient
ammonium nitrate	34-0-0	N
urea-ammonium sulphate	34-0-0-11S	N
ammonium sulphate	21-0-0-24S	N
urea	46-0-0	N
anhydrous ammonia	82-0-0	N
ammonium phosphate-sulphate	16-20-0-14S	N,P
monoammonium phosphate	11-48-0,11-51-0,11-55-0, 11-54-0	N,P
diammonium phosphate	18-46-0	N,P
muriate of potash	0-0-60, 0-0-62	K

Potassium Fertilizer

Potassium will move in the soil more readily than phosphorus, but for annual crops, potassium fertilizers are more efficient when drilled with or near the seed. Broadcast at about twice the rate used for drill-in application. For small-seed crops, the maximum safe rate for drill-in applications is 8 kg/ac. Broadcast applications can be made in either fall or spring.

Potassium Fertilizer Sources

1) Muriate of potash (0-0-60 or 0-0-62):
   - most commonly available potassium fertilizer
   - used directly as a broadcast application or mixed with phosphate and nitrogen fertilizers to make fertilizer grades such as 10-30-10, 8-24-24, 13-13-13, etc. Note--the cost of potash in some of the complete fertilizers tends to be considerably higher than in 0-0-60 or 0-0-62. Prices should be compared on the basis of cost per kilogram (pound) of nutrient.

FERTILIZER PLACEMENT AND APPLICATION

The following are brief descriptions of methods commonly used to apply fertilizer to vegetable crops.

Broadcasting refers to spreading a granular fertilizer on a soil surface before a crop has been seeded. Incorporation into the soil follows broadcasting usually as part of seedbed preparation. Broadcasting is usually done in the spring, but it can be done in the fall as well. See the previous sections on timing of fertilizer applications for limitation of fall applications.

Broadcasting is not an efficient method when rows are spaced far apart and plant roots do not meet between rows.

Top Dressing is the spreading of fertilizer on a field while the crop is growing. It is not incorporated, but the crop may be irrigated to wash granules off the leaves to prevent burning. Normally it is restricted to nitrogen which can move into the soil quickly. Top dressing, banding and fertigation are used primarily to apply nitrogen to crops when initial amounts of nitrogen may be low, yet the crop still has a need for additional nitrogen.

Drilling is the application of fertilizer near the seed in the same drill row or furrow. Applicators should be set so that as little fertilizer as possible is placed directly with the seed. Some mixing of seed, fertilizer and soil should occur. Phosphorus fertilizers are commonly applied to large seeded vegetable crops by drilling.

Banding is the application of fertilizer in a continuous band 5 cm (2 in.) to the side and below the seed at the time of planting. It is an efficient method of applying phosphorus fertilizer.

Side-Dressing is the banding of fertilizers in the soil to the side of the crop row after plants are established. Care should be taken not to damage crop roots.

FERTIGATION

Fertigation is the process by which a fertilizer solution is placed into irrigation water. It can be carried out by either the use of a metering injector pump or by feeding the fertilizer solution into the pump intake line by 'suction' or gravity. Either liquid or dry soluble fertilizer solutions can be used.

Advantages of fertigation are: close control over amounts applied, low application costs, ability to apply nutrients at any time according to crop needs, no mechanical damage to the crop, elimination of soil compaction, and uniform application when irrigation water is applied uniformly.

Disadvantages of fertigation include: higher cost of fertilizer, inconvenience of applying fertilizer at the start of each new irrigation set, potential corrosive damage to equipment if systems are not flushed after use, and lack of uniform nutrient

application if irrigation water is not applied uniformly.

Information on fertigation equipment can be obtained from Alberta Agriculture, Irrigation Division offices in Lethbridge, Brooks, Taber, Bow Island, Medicine Hat, Strathmore and Airdrie. The Airdrie Regional Agriculture office serves central and northern Alberta.

SECTION 5
IRRIGATION MANAGEMENT

WATER USE

Adequate and timely irrigation produces high yields and top quality produce. The tubers and bulbs of some crops such as potatoes and onions will have a high dry matter content when they receive sufficient irrigation throughout the growing season. Both excess and insufficient irrigation can cause delayed growth and maturity, and in some cases may encourage the development of disease or soil salinity.

The amount and frequency of irrigation depends upon the kind and stage of development of the crop, the water holding capacity of the soil and the climate. Climatic factors include: temperature, sunlight, wind, precipitation, and relative humidity.

Vegetable crops that have small seeds may require light frequent applications of water to facilitate emergence of seedlings. This is particularly important when soil crusting is a problem. Small applications of water should wet the top layer of the soil. A depth of 10 mm (0.4 in.) of water per application should be sufficient. If more water is applied, it will increase the likelihood of crusting and will not keep the soil surface moist longer than a small irrigation. Small irrigations can be successfully achieved by using sprinkler irrigation systems. It is important to use a sprinkler system designed according to the needs of the crop. Proper sizing of sprinkler nozzles operating at the designed system pressure will ensure a uniform application of water.

The depth from which crops can effectively draw moisture varies with the rooting depth of each crop. The allowable depletion of soil moisture varies with the crop and, to a lesser extent, the stage of crop development. Allowable depletion is the level of dryness that the plants can tolerate and still produce the desired yield. It is usually expressed as the percentage of available moisture in the root zone. (See table 8). The available moisture in the root zone can be estimated by the feel method on page 50.

The timing of irrigation for a vegetable crop and the amount of water to be applied at each irrigation depends upon the rooting depth, soil texture and the amount of moisture stress the crop can tolerate. A shallow rooted crop like onions can effectively draw moisture from 0.6 m (2 ft.). If the allowable depletion exceeds 35%, the yield is reduced. For example, a loam soil has 17 mm/0.1 m (2 in./ft.) of moisture available for crop use or 102 mm (4 in.) in 0.6 m (2 ft.) depth. Since the allowable depletion is 35%, then 36 mm (1.4 in.) of water can be removed from the root zone before an irrigation will be required. In mid-summer, the consumptive use of onions is about 5 mm (0.2 in.) per day. At this time an irrigation will be required every seven or eight days (assuming no rainfall occurs and normal crop growth and development is taking place) with a net application of 36 mm (1.4 in.) of water (table 8).

Carrots have an effective rooting depth of 0.9 m (3 ft.) and an allowable depletion level of 40%. If carrots were to be grown on a sandy loam soil, which has 13 mm/0.1 m of water available for crop use, in a 0.9 m root zone, 90 mm of water is available for crop use. Since the allowable depletion level for carrots is 40%, then 47 mm of water can be depleted from the root zone without putting the crop under stress. Moisture use by carrots will vary from 3 mm/day at the end of June to about 6 mm/day towards the end of July. Crop water use will increase with hot or windy weather and decline in cool periods. Weeds will increase water use. Typical seasonal water use is shown for potatoes on page 50.

The available soil moisture for crop use varies with the texture.

Soil Texture	Available Moisture
Loamy sand	8-12 mm/0.1 m (0.9 - 1.4 in./ft)
Sandy loam	10-15 mm/0.1 m (1.2 - 1.8 in./ft)
Loam	14-18 mm/0.1 m (1.7 - 2.2 in./ft)
Sandy clay loam, Clay loam, Clay	15-20 mm/0.1 m (1.8 - 2.4 in./ft)
Silty clay loam, Silt loam	16-22 mm/0.1 m (1.9 - 2.6 in./ft)

mm - millimetre, m - metre

Table 8.
Irrigation Scheduling for Vegetables

Crop & Root Depth	Soil Water Holding Capacity	Available Moisture Held in Root Zone	Safe Depletion %	Moisture Safely Depleted	Daily Water Use	Irrigation Frequency
Onions .6 m (2 ft)	Loam 17 mm/0.1 m (2.0 in/ft)	102 mm (4 in)	35	36 mm (1.4 in)	5 mm (0.2 in)	7 days
Carrots 0.9 m (3 ft)	Sandy Loam 13 mm/0.1 m (1.5 in/ft)	117 mm (4.5 in)	40	47 mm (1.8 in)	June 20 3 mm (0.6 in)	16 days
Carrots 0.9 m (3 ft)	Sandy Loam 13 mm/0.1 m (1.5 ir./ft)	117 mm (4.5 in)	40	47 mm (1.8 in)	July 30 6 mm (0.24 in)	8 days

The recommended allowable depletion of available moisture for most vegetable crops is as little as 25% for lettuce and as high as 50% for beans or beets. The most critical periods to avoid moisture stress is during seedling emergence and from flowering through seed formation, or during head, bulb or tuber development. Inadequate irrigation during these critical periods will cause low yields and poor quality produce.

Table 9.
Irrigation Requirements of Vegetables.

Crop	Rooting Depth Metres (ft)	% Allowable Depletion of Available Moisture*	Comments
Beans (fresh market)	0.9 (3)	40	Beans are sensitive to moisture stress from flowering to seed formation. A waterlogged soil during flowering or pod formation stages will reduce seed yields and encourage the development of disease.
Beans	0.9 (3)	50	
Beets	0.9 (3)	50	
Broccoli and Cabbage	0.75 (2.5)	35	Broccoli and cabbage are sensitive to moisture stress at all stages but most sensitive at the time of head formation and growth.
Carrots	0.9 (3)	40	Several small applications of water near the time of emergence will aid in obtaining a uniform stand. Carrots are sensitive to moisture stress during the root enlargement period. In the fall, an excessively wet soil will encourage the development of soft rots.

Crop	Rooting Depth Metres (ft)	% Allowable Depletion of Available Moisture*	Comments
Corn (sweet)	1.0 (3.2)	40	Corn is sensitive to moisture stress from tassel to seed formation stages.
Cucumbers	0.6 (2)	50	Available soil moisture should be kept above 60% after flowering begins.
Lettuce	0.6 (2)	25	Lettuce is sensitive to moisture during head formation. Excessive moisture in the seedling stage may cause them to die off.
Onions	0.6 (2)	35	Irrigation water (light applications) may be needed early in the spring to aid emergence. Moisture stress during the bulb formation period will reduce the yield and the dry matter content. No watering after the third week of August should occur to allow time for ripening of bulbs.
Parsnips	1.0(3.2)	40	
Peas	0.6 (2)	30	Peas are most sensitive to moisture stress from the beginning of flowering through pod formation and they are sensitive to water- logged soil.
Peppers	0.9 (3)	30	Moisture stress during flowering and fruit development will reduce yields.
Potatoes	0.8 (2.5)	30	Potatoes are sensitive to moisture stress from tuber formation until ripening of the vines begins. If the soil is kept moist at the time of tuber formation, this increases the number of tubers formed but reduces the average size of tubers. Late potatoes which do not suffer moisture stress will have a higher dry matter content than potatoes grown under an intermittent water supply.
Tomatoes	0.9 (3)	40	Tomatoes are sensitive to moisture stress from the time of flowering through to full enlargement of the fruit.

*A crop that has an allowable depletion of 25% of the available moisture will require irrigation twice as often as a crop that has an allowable depletion of 50%, if they have the same depth of rooting and daily water use. Available moisture is the water which is held in the root zone between field capacity and permanent wilting point. In general, vegetable crops are more sensitive to water deficiency during emergence, flowering and early produce formation than they are during early (vegetative) and late growth periods (ripening).

METHODS OF IRRIGATION

The type of irrigation system chosen will depend upon the topography, type of soil, water supply, crops to be grown, size of the field, and the amount of capital and labor the farmer has access to. Estimate of capital, fuel, and labor costs for different kinds of irrigation systems are given in table 10. The merits and limitations of some systems are discussed below.

Surface Irrigation

Surface irrigation of vegetable crops is usually done by the furrow method. The design and layout depends on the crop to be grown, the slope of the terrain, the soil type and the water supply.

With furrow irrigation only a part of the soil surface is flooded. Movement of water into the soil is both lateral and vertical. In most cases, irrigation of alternate furrows will give results almost equal to irrigating every furrow. From a practical standpoint,

Table 10.
Comparison of Irrigations Systems Costs for 1988

Assumptions:

Water available at the edge of the field.
Net water applied 300 mm (12 in.)
160 acres irrigated by wheel rolls & surface methods.
132 acres irrigated by centre pivots.
Cost of installing electric or natural gas line not included.
Annual water rates of $7-15/acre not included.

System	Capital Cost $/acre	Annual Costs in $/Acre* Fixed Cost	Labor	Maintenance and Repairs	Energy	Total
High pressure pivot 480 kPa	520	73	2	7	11-22	93-104
Low pressure pivot 340 kPa	480	69	2	7	8-17	86-95
4 wheel roll laterals 12 hr sets	363	53	6	5	10-20	74-85
Trickle 280 kPa	1,300	264	2	9	5-10	280-285
Gated pipe	482	58	6	4		68

*Multiply $/acre by 2.47 to obtain $/ha.

Annual fixed costs plus repair and maintenance vary significantly between fuel types.

Energy costs vary according to the type of fuel used. Costs as compared to natural gas are: electricity A 2.1, Electricity B 1.4, Propane 1.6, and diesel 2.0. This is based on natural gas at $2.70/GJ, Propane $0.14/L and Diesel $0.31/L.

land slopes should be less than 2% and preferably less than 1% for efficient water application. Usually, land levelling is necessary to eliminate low spots where water would otherwise pond.

Precise water control can be maintained with siphons or gated pipe because furrow stream sizes can be adjusted to fit the particular need. The use of gated pipe eliminates seepage and weed problems associated with open unlined ditches.

Trickle Irrigation

Trickle irrigation is ideal for vegetable production where the water supply is limited. Water savings of 30 - 70% compared with furrow or sprinkler irrigation can be realized. Water is applied through a network of supply lines and laterals at a slow rate at or near the soil surface. Typical operation pressures are 70 - 200 kPa (10 - 30 psi). Lateral tubing of either the double chamber or porous type will give a continuous wetting strip down the row.

Placing the tubing in the seed row will further reduce water use and aid in controlling weeds. The type of water filtration needed depends upon the initial water quality and the type of lateral used.

For vegetable crops such as carrots, tomatoes and cucumbers, a double row culture with one trickle line between the closely spaced double rows is recommended. This results in a higher plant population than in single row culture and reduces the amount of trickle tubing required. The high capital costs of equipment will limit the use of trickle in large scale field installations. (For further information see Alberta Agriculture Agdex sheet 568-3.)

Sprinkler Irrigation

Sprinklers have advantages because they are adaptable to almost any soil or topographic condition and can apply variable amounts of water including small applications to promote germination. However, the capital and operating costs of sprinkler systems are high.

Hand Move

Hand move systems made of portable aluminum tubing are best suited to small acreages

such as market gardens. They can be used at the germination stage if the pressures are high enough to provide a fine droplet size. If small water applications are required, the lateral lines have to be moved often, which requires high labor. In cases where the value of the crop warrants it, enough hand move laterals can be used to cover the entire field. This "portable solid-set" system is laid out in the spring and left until fall when it is removed. Frost protection is also possible with a solid set system. The labor involved would be the opening and closing of valves. The capital cost of the equipment would be very high compared with a portable hand move system. On small acreages, the pumping unit is the main initial cost of any sprinkler system.

Wheel Roll

Wheel roll systems are the most common sprinkler type in Alberta. For vegetable crops, four 400 m (1/4 mile) laterals per quarter section are required for high yield and quality. Where surface crusting is a problem or when irrigation for germination is required, the nozzle size of the sprinklers can be reduced to produce a finer droplet size. Equipment costs vary depending on the number of laterals that are required. Acreages smaller than a quarter section can also be irrigated with wheel roll systems, but the unit cost is higher and if the field is not rectangular in shape, the relative labor requirements are increased.

Centre Pivot

Centre pivot systems are also suited to vegetable crops provided a large area free of obstructions is available. Some operators have a quarter section pivot of which one-half or one-quarter of the circle is in vegetable crops. Shorter center pivot machines are available, and although the unit cost is high, they may be a viable alternative for vegetable crops. Major advantages of pivots are: they require a small amount of labor, they can operate on rough topography, and their speed can be varied to permit light applications and so better water management. Due to the tracks made by centre pivot towers, a vegetable grower may want to consider planting and harvesting in a circle.

Travelling Volume Guns

A volume gun is one large sprinkler which can discharge from 0.2-1 m^3/minute (100 and 500 US gallons/minute). These sprinklers are set up and operated in one spot and then moved to a new location. They may be self-propelled. (Due to the high water application rates, they may damage tender young crops). Volume guns require a high operating pressure and therefore have high energy costs. However, they are very adaptable to odd shaped fields and to tall crops, as found in tree nurseries.

FERTIGATION

Fertigation is the application of nutrients through an irrigation system. Refer to fertilizer placement and application in the soil management and fertility section.

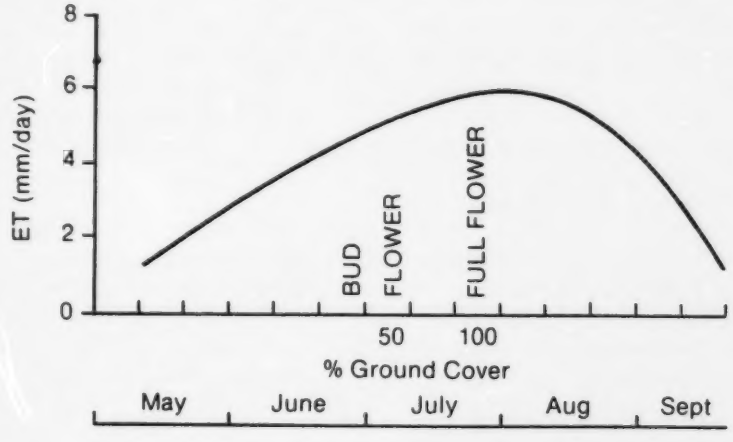
IRRIGATION INFORMATION

Details on developing an irrigation scheduling program, cost analysis for selecting and designing an irrigation system, soil evaluation for irrigation, and drainage designs can be obtained from Alberta Agriculture, Irrigation Branch. Offices are located in Lethbridge, Brooks, Taber, Bow Island, Medicine Hat, Vauxhall, Strathmore and Airdrie. The Airdrie office serves central and northern Alberta.

		Feel or Appearance of Soils		
	PERCENT OF AVAILABLE MOISTURE REMAINING	**MODERATELY COARSE TEXTURE**	**MEDIUM TEXTURE**	**MODERATELY FINE TEXTURE**
DO NOT IRRIGATE	At field capacity 100	Upon squeezing no free water appears on soil but wet outline of ball is on left hand.	Same as sandy loam.	Same as sandy loam.
	75 to field capacity	Forms a weak ball, breaks easily, will not slide.	Forms a ball and is very pliable; slicks readily if relatively high in clay.	Easily ribbons out between fingers,has a slick feeling.
IRRIGATE SPEC. CROPS	50 to 75	Tends to ball under pressure but seldom will hold together	Forms a ball; somewhat plastic; will sometimes slick slightly with pressure.	Forms a ball, will ribbon out between thumb and forefinger.
IRRIGATE	25 to 50	Still appears to be dry, wil not form ball with pressure.*	Somewhat crumbly but will hold together from pressure.	Somewhat pliable, will ball under pressure.
	0 to 25	Dry, loose, single-grained, flows through fingers.	Powdery, dry, sometimes slightly crusted but easily breaks down into powdery condition.	Hard, baked, cracked; sometimes has loose crumbs on surface.

* Ball is formed by squeezing a handful of soil firmly.

Practical Interpretation Chart for Available Soil Moisture.



Evapotranspiration During the Growing Season

SECTION 6
VEGETABLE PRODUCTION RECOMMENDATIONS

This section gives specific crop recommendations for vegetable crops and outlines the accepted practices for each crop. It is not possible in a publication like this to cover all contingencies that may occur with any crop and growers who are faced with the unexpected are encouraged to contact one of the specialists listed on the back cover. Processing vegetable crop growers should contact their contracting company fieldman.

Although many recommendations are based on research that has proven these to be the best methods, some of the recommendations are based on accepted practices in Alberta or other production areas.

The following are brief explanations of the recommendations that are made for each crop.

VARIETIES (CULTIVARS)

The varieties recommended are based on trials that have been conducted primarily in Brooks. Over the past years there have been hundreds, and in some cases thousands of new varieties developed for each crop. The varieties that are recommended are those that have done the best out of the many that have been tested in Alberta. Growers who are starting a new crop should begin with recommended varieties because the recommendations are based on accurate measurement of their performance.

FERTILIZER

The recommendations listed are to be used as a guide only. Growers should soil test every year. The small fee charged for a soil test can more than pay for itself through increased yields where fertility is low or through fertilizer savings where fertility is high.

Fertilizer recommendations are based on research conducted in Alberta or on a consensus of recommendations from other production areas. Normally, nitrogen and phosphorus are the only fertilizers required in Alberta. Potassium levels are normally high in most Alberta soils and the addition of potassium has not shown consistent results in fertilizer tests. Recommendations for potassium have not been made, but this nutrient may be required in some areas as shown on soil test reports.

If possible growers can band nitrogen and phosphorus near the seed rows. The amount of fertilizer used can be reduced if it is banded. The benefits of banding depend on the plant populations used. When narrow row spacings are used the benefits of banding are decreased and fertilizer can be broadcast.

Growers are urged to soil test and base fertilizer applications on the results of these tests.

WEED CONTROL

The chemicals listed in this guide are registered for the stated use. There may be other products that are registered but not listed. It is illegal to use chemicals that are not registered for a specific use.

The chemicals recommended are registered for use in Alberta. Rates are in the amount of Actual Product. Most herbicides are applied in 90 to 180 litres of water per acre unless otherwise noted. FOLLOW INSTRUCTIONS ON THE LABEL. Generally herbicides do not control all weeds and growers should be fully aware of potential weed problems and be prepared to control them accordingly through crop rotation and cultivation.

The specific weeds controlled by all chemical have not been listed. Refer to table 7 or contact the weed control specialist listed on the back cover of this publication for more detailed information on application and specific weeds controlled. Product labels list application methods and weeds controlled.

Because of the relatively small acreage of many vegetable crops, either in Alberta or elsewhere, chemicals have not been developed for all crops. A number of herbicides registered for use in the U.S. are not registered in Canada because of their limited market. The development, testing and registration process is a long and costly procedure, which often cannot be justified by chemical companies because of the limited economic potential. When chemicals are not registered for use on a specific crop, growers must use crop rotation and cultivation to control weeds. An added method is to use contact herbicides for the stale seedbed method (see page 24) before crop emergence and to use contact herbicides around crop areas after crop emergence. Whatever herbicide is used, the vegetable producer is advised to order his supply well in advance of anticipated use.

INSECT CONTROL

The chemicals listed in this guide are registered for the stated use. There may be other products that are registered but not listed. It is illegal to use chemicals that are not registered for a specific use.

All pest control chemicals are toxic; however, insecticides generally are more toxic to man than other pesticides. FOLLOW THESE RECOMMENDATIONS AND THOSE ON THE PRODUCT LABEL. Chemical rates recommended are given as the amount of Actual Product. Consult the insect control specialists listed on the back cover of this guide or company representatives if more detailed information is required.

The 'number-of-days-to-harvest' follows each recommendation, for example: (7 days). This means the chemical should not be applied within seven days of harvest. Some products, e.g. Thiodan and Lorsban, have restrictions on feeding crops or crop refuse to livestock after treatment with these products. Check all labels for such restrictions before use.

DISEASE CONTROL

The diseases discussed are those that have caused crop injury in Alberta. Chemicals listed for control are registered for use in Alberta. Most crops can be attacked by many diseases if a pathogen source is present and environmental conditions are right. Not all potential disease problems are covered in this guide. Consult the nearest plant pathologist listed on the back cover of this guide for more detailed information on diseases. Growers must recognize the importance of crop rotation and sanitation in the prevention of crop disease. All recommendations are given as the amount of Actual Product unless otherwise noted.

ABBREVIATIONS USED

The following abbreviations are commonly used on pesticide containers and in the recommendations used in this guide:

a.i. = active ingredient
DF = dry flowable
DU = dust
EC = emulsible concentrate
F = flowable
G = granular
L = liquid
SC = soluble concentrate
SL = soluble liquid
SN = solution
SP = soluble powder
SU = suspension
WP = wettable powder

GRADE STANDARDS

Grade standards are regulated by both the federal and provincial governments. Not all vegetable crops are governed by grade regulations; however, where no legal regulations exist, a grower must only offer top quality produce for sale that is fresh and free from blemishes, diseases and insects.

The grade standards outlined in the Grades and Packaging Standards section of each crop covered in Section 6 of this guide are intended only as a reference and have no official sanction. Producers should contact the nearest Agriculture Canada office of the Fruit and Vegetable Inspection Division for specific details. In most cases, Alberta regulations are the same as the federal regulations. There are some exceptions where a special provincial grade may be packaged and offered for sale within the province of Alberta.

All fresh market produce must be packaged according to the regulations to meet wholesale market requirements. Guidelines to packaging regulations are available by refering to page 17 of this guide or by contacting:

Alberta Fresh Vegetable Marketing Board
220E - 12 Street A, North
Lethbridge, Alberta T1H 2J1

ASPARAGUS

Varieties

Viking selections

Soil

Fertile, well drained loam to sandy loam.

Planting from seed

Growers may produce crowns from seed, or purchase one-year-old crowns if available.

If planted from seed, asparagus can be planted in a temporary location for one year to save space or it may be planted in the permanent location. While the latter uses more space for one year, it does save moving the plants the following spring.

400 g (1.0 lb) of seed should produce about 8,000 plants per acre, however, only strong plants should be used when transplanting for as many as one half of the seedlings may be discarded because of weakness, disease, etc.

Seed when soil is above 15°C. For transplant stock that will be moved, sow seed 2-3 cm (1-1.5 in.) deep, with 10-15 cm (4-6 in.) between plants and 60 cm (2 ft) between rows.

If seeds are to be planted in their permanent location, sow seeds 2-3 cm (1-1.5 in.) deep in a furrow 15-20 cm (6-8 in.) deep at 12 seeds per metre (4 seeds per foot). The furrow should be 1.2 metres (4 ft) apart. Thin to 30 cm (12 in.) apart in the row when emergence is complete. Fill in the furrows gradually as the plants grow.

Planting from established plants

In early spring of the year following seeding, dig the year-old-plants, discard the weak plants, and plant vigorous crowns 2-5 cm (1-2 in.) deep in a 20 cm (8 in.) deep furrow. Strong plants should have at least 10 roots. Space the plants 30 cm (12 in.) apart in furrows 1.2 metres (4 ft.) apart. Spread the roots and cover with not more than 5 cm (2 in.) of well firmed soil. Fill in the furrows as the plants grow during the second growing season until the furrows have been filled level with the field. Keep the asparagus bed free from weeds at all times.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Asparagus is a deep rooted perennial that requires adequate nutrient levels at the root zone. It is necessary that nutrient levels, especially of phosphorus, be adequate prior to planting. Phosphorus moves down slowly in the soil and it will take several years for phosphorus added on the surface to move into the root zone where it can be used.

The summer or fall prior to establishing an asparagus field a heavy 18 t/ac application of well rotted manure should be applied.

Prior to planting, apply and work in 135 kg/ac of 11-55-0 and 90 kg/ac of 34-0-0 or the equivalent.

Reduce fertilizer amount as indicated by the soil test.

Each spring apply the following to established plants: 90 kg/ac of 34-0-0 and 45 kg/ac of 11-55-0 or the equivalent.

Each fall after cutting an established planting, apply 40 kg/ac of 34-0-0. Broadcast and work in lightly. Allow ferns to develop after application. The nitrogen may also be added through the irrigation water.

Check fertility levels with annual soil tests.

Apply 10 t/ac of well rotted manure every 3 to 4 years.

Weed control

Perennial weeds should be completely eradicated before planting or seeding asparagus. These weeds are difficult to control with chemicals and deep cultivation may damage the asparagus crowns.

If started from seed, Gramoxone (paraquat) should be applied a few days before the seedling emerges to destroy weed growth. (See Stale Seedbed, Section 3.) Later on, control can be aided by burial as the furrows are gradually filled in.

Herbicide Trade Name (generic name)	Product Rate (per acre)	Remarks
A) BEFORE EMERGENCE OF DIRECT SEEDED CROP		
Gramoxone (paraquat)	1.1 - 2.2 L	Spray on emerged weeds before crop emerges. Thoroughspray coverage is essential for effective weed control. Use 120-445 L/ac of water.
Amiben 240 g/L (chloramben)	3.7 - 5.5 L	Apply before emergence of asparagus to a weed-free surface. Incorporate with irrigation. Do not tank mix Amiben and Gramoxone.
B) ONE YEAR OLD CROWNS ESTABLISHED		
Amiben 340 g/L (liquid) or Amiben 75 DS (dry soluble) or Amiben 10 G (granular) (chloramben)	3.7 - 5.5 L 1.2 - 1.8 kg 9.1 - 13.1 kg	Apply as a pre-emergence spray or as a granular application on emerged seedlings. Do not use on marketable asparagus.
C) ESTABLISHED ASPARAGUS, 2 YEARS OLD OR MORE		
Princep Nine-T or (simazine)	1.0 - 1.5 kg	Apply one of the following herbicides in the left column after discing in spring, prior to weed and spear emergence and at least 7 days prior to first cutting. Do not apply during the harvest period. The lower rates are recommended for light soils. Use Simazine and Treflan only on plantings established at least 3 years. Apply Treflan with 40 L/ac of water. Apply other herbicides with at least 120 L/ac of water. Treflan must be incorporated by discing. Irrigation or precipitation is required after application to activate these herbicides. As an alternative to early spring application, linuron, simazine, diuron and trifluralin can be applied after harvest (weeds must be removed).
Simazine 80W or (simazine)	1.1 - 1.7 kg	
Karmex (diuron)	0.44 - 0.9 kg on sandy soils; 0.9 - 1.8 kg on clay or high organic matter soils	
Lorox 480 L or (linuron)	1.4 - 1.8 L	
Afolan 450 F or (linuron)	1.5 - 2.0 L	
Sencor 500 F or (metribuzin)	0.9 - 1.8 L	
Treflan 545 EC (trifluralin)	1.8 L on light soil; 2.7 - 3.7 L on medium to heavy soil	
MCPA amine or MCPA ester or 2,4-D amine	1.4 L 1.4 L 0.2 - 0.45 L	Apply after cultivation just before spears appear. May repeat application after harvest. Apply with 20-40 L/ac water.

Herbicide Trade Name (generic name)	Product Rate (per acre)	Remarks
Amitrol-T (200g/L amitrol)	8.9 L	Apply after harvest is complete. Amitrol-T may be used as a spot treatment to control patches of perennial weeds. Application should be made when weeds are actively growing. Avoid contact with asparagus leaves.
Gramoxone (200 g/L paraquat)	1.1 - 2.2 L	Apply to weed seedlings before spears appear or after last cutting. Do not apply to spears. Use higher rate when weeds exceed 5 cm in height.

Insect control

Asparagus aphid

Green aphids produce 'witches' broom' type of growth and numerous thin spears. Limited distribution as yet. Destroy or burn old fern growth.

Apply one of the following foliar sprays:

Phosdrin 60 SN at 182 ml/ac (1 day) - Repeat as necessary, or

Rotenone 5 WP at 4 to 5 kg/1000 L (4 to 5 lb/100 gal) (1 day) - Repeat at 5-7 day intervals as necessary.

Disease control

Crown rot (fusarium) and seedling blight

Rotate asparagus fields with grasses or cereals. Otherwise, fumigate soil with methyl bromide* or Vorlex* prior to planting. Follow all precautions on labels carefully. Soak seed for 2 hours in bleach mixed at a ratio of 1 L Chlorox to 5-10 L (1.5 pints in 1-2 gallons) water. Agitate the seed periodically. Plant disease-free crowns or treat them before planting with Benlate 50 WP at 2.0 g/L (0.32 oz/gal). Dip 3000 crowns in 1000 L (20 gal) for 15-20 minutes. Do no cultivate deeper than 10 cm (4 in.).

* CAUTION, VERY TOXIC.

Rust

Plant only on sites with good air circulation. Destroy volunteer plants in or near asparagus fields. Irrigate early so that plants do not remain wet overnight. The cultivar, Viking 2K has moderate field resistance. Spray ferns every 10-14 days as required with Zineb 80 WP at 1.3 kg/ac or Polyram 80 WP at 1.3 kg/ac, after harvest before rust pustules appear.

Special problems

Harvesting

Harvesting may be done on a limited scale in the third year after seeding or the second year after planting one year-old crowns.

In the first harvest year cut all spears when about 12-20 cm (5-8 in.) high, and only for about 2-3 weeks. In the second cutting year, harvest about 3 to 4 weeks only, and in the third and subsequent cutting years harvest for no longer than 4 weeks. In southern areas, where more growth accumulates after harvest, asparagus may be cut for up to 6 weeks.

Excessive cutting in any season may seriously reduce crown vigor and result in reduced yields the following year. If this does occur, shorten the cutting season that year to let the crowns built up reserve food to ensure a vigorous growth of spears the following year.

The spears should be harvested about twice a week. However, during hot weather a daily harvest may be required because the spears grow rapidly.

Postharvest field care

After the cutting season broadcast 45 kg/ac of 34-0-0 and work in to the top 5 cm (2 in.) of soil. Irrigate and allow ferns to develop for the remainder of the summer and fall. Let ferns stand throughout the winter. The old stalks can be disced down the following spring either before or after fertilization.

Storage and handling

Asparagus is extremely perishable and is normally marketed directly after harvest. It should be placed in storage only as a temporary measure if it cannot be marketed immediately.

Asparagus should be cooled to 0°C immediately following harvest and held at a humidity exceeding 95%. Under these conditions storage life can be extended up to 3 weeks. After 3 weeks of storage, shelf life is short.

Grade and packaging standards

The following is a guide and has no official sanction.

Generally Canada No. 1 asparagus is fresh; has smooth evenly cut ends; is free from specimens having tips that are broken, spreading or having seedy appearance; is free from decay and free from injury and blemish; has not more than 15% of each stalk white; has stalks of a minimum diameter of 0.8 cm (5/16 in.) and a minimum length of 14 cm (5.5 in.) and when packaged do not vary more than 3.0 cm (1.5 in.) in length.

Canada No. 2 asparagus is free from decay, free from injury or defect that seriously affects appearance, edibility or shipping quality and has no more than 15% of each stalk white. Overall general tolerances are also specified. No specific package sizes are required.

BEANS

Varieties

Fresh market green beans: Bronco, Earliserve, Slim Gym, Delta, Masai 47, Tendercrop, Topcrop, Bush Blue Lake.

Fresh market wax beans: Eastern Butter Wax, Goldrush, Earliwax, Key Gold.

Process market: as required by processor.

Dry beans: Pinto 111, Fiesta (pinto); Seafarer, Snowflake (small white); Red Mexican 36, Garnet (small red); Viva, Harold, Victor (pink); Great Northern 1140 (large white).

Broad beans: Broad Windsor, Exhibition Long Pod.

Seed treatment

Purchase fungicide-treated seed or treat seed with either Captan or Thiram seed treatment.

Seeding and spacing

Snap Beans: Snap beans will germinate at temperatures above 15°C. Beans may suffer from extensive seed rot if planted into soil colder than 15°C.

Bean seeds crack easily and should be handled with care. The seeder or planter should not crack or split the seed. Seeds should be placed about 3-5 cm (1.5-2 in.) deep.

Snap beans grown for processing must be planted in rows that are matched to the mechanical harvester used. Spacing and seed rates are given by the processor.

Beans grown for fresh market are normally hand harvested and grown in rows 60-90 cm (24-36 in.) apart. Seed is placed 3-5 cm (1.5-2 in.) apart in the row. About 30 kg/ac of seed are required.

Dry Beans: Seed handling and planting requirements are similar to snap beans. Row spacings are governed by harvesting equipment. Normal spacings are 60 cm (24 in.) between rows and 5-7 cm (2-3 in.) within the row. About 20 to 30 kg/ac of seed are required.

Broad Beans: Broad beans can be planted into cooler soil than snap or dry beans. Good emergence can be expected when the soil temperature is above 10°C. Broad beans are grown in rows 90-100 cm (36-40 in.) apart and with about 7-10 cm (3-4 in.) between plants. About 100 kg are required per 100 metre of row (65 lb/100 ft of row) or about 70 kg/ac.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Beans are legumes and have the ability to use nitrogen from the air provided the necessary soil organisms are present. All bean seed should be treated with an inoculant that adds organisms to the soil that help the plants to fix nitrogen.

Broadcast and work in before planting, 20 kg/ac of 11-55-0 and 45 to 55 kg/ac of 34-0-0 or the equivalent.

The amount of nitrogen required will be less in soils where beans have grown before and there are sufficient soil organisms established that will fix more nitrogen in the soil. Drill about 20 kg/ac of 11-55-0 near the seed rows at seeding time.

Adjust fertilizer application as indicated by soil test results.

Weed control

To provide broad spectrum weed control, it is generally necessary to use a preplant incorporated (PPI) herbicide. A follow-up application with a pre-emergence or postemergence herbicide may be required to control 'escape' weeds.

Herbicide Trade Name (generic name)	Product Rate (per acre)	Remarks
A) PRE-PLANT INCORPORATED		
Treflan 454 EC or Rival 500 EC (trifluralin)	0.6 - 0.8 L 0.65 - 0.89 L	Use the lower rate on sandy soils with less than 6% organic matter. Apply in 40L/ac of water. Incorporate within 24 hours of application into soil in two different directions or in one direction with a rotovator. Incorporation can also be accomplished with a tandem disc, disker or field (vibrashank type) cultivator set to work 8 to 10 cm (3 to 4 in.) deep. As a precautionary measure, do not plant red beets, sweet corn, vine crops, oats and small seeded annual grasses in rotation following use of trifluralin. Registration is pending.
Eptam 8-E (800 g/L EPTC)	1.7 - 2.2 L	Apply to a dry soil surface with 40 L/ac of water. Incorporate immediately following label directions. Break crust lightly with a rotary hoe if necessary to assist emergence.
B) POSTEMERGENCE		
Basagran (480 g/L bentazon)	0.71 - 0.91 L Add assist oil concentrate according to label directions	Apply in 80 to 160 L/ac of water after first trifoliate leaf stage and weeds are small and actively growing. Add assist oil concentrate, 810 ml/ac, to increase performance. This contact herbicide must be applied at a minimum spray pressure of 275 kPa to give good weed coverage. Redroot pigweed should be treated before the 4-leaf stage. A split application is recommended for the top growth control of Canada thistle.
Hoe-Grass 284 (diclofop methyl)	1.4 L. Add assist oil concentrate according to label directions.	Apply in 45 L/ac of water at 275 kPa with spray at a 45° angle forward. Weeds should not be under stress.

Herbicide Trade Name (generic name)	Product Rate (per acre)	Remarks
Poast E.C. (184 g/L sethoxydim)	maximum 0.77 L Add assist oil according to label directions.	Water volume required is 20 to 44 L/ac. Tilt spray boom forward 45° for better coverage. Treat when grasses are actively growing and at recommended leaf stage. Allow 4 days between application of Poast and any other chemical. Do not allow spray mixture to sit overnight. Addition of ammonium sulphate enhances control. Interval from application to harvest is 60 days.

Recommended Growth Stages of Grasses and Application Rates of Graminicides.

Herbicides	Product Rate (per Acre)	Grasses Controlled
Excel	1 L	wild oats, green and yellow foxtail, barnyard grass (1-6 leaf stage), volunteer barley (3-6 leaf stage), volunteer corn (5-25 cm)
Fusilade[x] 250 EC	325 ml	barnyard grass, Persian darnel, volunteer barley and spring wheat (2-5 leaf stage)
	400 ml	wild oats, proso millet (2-5 leaf stage)
	567 ml	green and yellow foxtail (2-3 leaf stage)
	810 ml	quackgrass (3-5 leaf stage) suppression
Hoe Grass 284 EC	1.4 L	wild oats, green and yellow foxtail, barnyard grass, Persian darnel, volunteer corn
Poast[y] (184 g/L)	325 ml	barnyard grass, green and yellow foxtail, Persian darnel, proso millet, volunteer corn (2-5 leaf stage)

Herbicides	Product Rate (per Acre)	Grasses Controlled
	570 ml 650 ml	wild oats (2-5 leaf stage) heavy infestations of wild oats
	570 ml 770 ml	volunteer barley, oats, spring wheat heavy infestations of volunteer barley
Poast[y] + Liquid Ammonium Sulphate	570 ml + 1.6 L	volunteer cereals plus other annual grasses listed above (2-5 leaf stage)
Poast[y]	1.78 L	quackgrass suppression, apply up to 3 leaf stage
Poast[y] + Liquid Ammonium Sulphate	1.09 L + 1.6 L	quackgrass suppression, apply up to 3 leaf stage

[x] Add Agral 90 at the rate of 1L for every 1000 L of spray solution. Do not add Agral 90 when Fusilade is tank mixed with other herbicides.
[y] Add Assist Oil Concentrate according to label directions. Water volume should preferably not exceed 44 L/ac.

Insect control

Aphid

Usually black or green species feeding on growing tips and leaf undersides.

Apply one of the following foliar sprays: Malathion 50 EC at 800 ml/ac (1 day) - Repeat as necessary, or Cygon 4 E (Lagon, System) 48 EC at 225 to 405 ml/ac (7 days) - Repeat as necessary, or Thiodan (Endosulfan) 50 WP at 445 to 600 ml/ac (2 days), or Phosdrin 60 SN at 180 mL/ac (1 day) - Repeat as necessary.

Alternative chemicals and formulations: Thiodan 4E 40 EC (2 days); Malathion 4 DU, 25 WP or 85 EC (1 day); Systox 24 EC, 72 EC (21 days), Diazinon 50 EC, 50 WP (3 to 14 days); Di-Syston 15G, 72 EC (60 days); Guthion 50 WP, 12 EC, 24 EC (3 days); Dibrom 86.4 EC (4 days); Thimet 10G, 15G (60 days); Rotenone 5 WP, 5 DU, 1 DU (1 day).

Spider mite

Tiny, sap-sucking mites on leaf undersides causing yellowing. Usually only a problem near urban areas.

Apply one of the following foliar sprays: Phosdrin 60 SN at 180 ml/ac (1 day) - Repeat as necessary, or Systox 24 EC at 700 to 910 ml/ac (21 days) - Repeat as necessary, or Dibrom 86.4 EC at 445 to 890 ml/ac (4 days) - Repeat as necessary.

Alternative chemicals and formulations: Lagon 480E (7 days); Systox 72 EC (21 days); Cygon 4E 48 EC (7 days); Di-Syston 15G, 72 EC (60 days); Malathion 4 DU, 50 WP, 50 EC, 85 EC (3 days); Thimet 10G, 15G (60 days); Kelthane 18.5 EC (7 days).

Thrips

Tiny black, rasping insects on leaves and flowers that cause silvering and bud blast if very numerous.

The following materials applied at seeding should provide some thrip control: Di-Syston 72 EC at 0.6 to 1.3 L/ac (60 days), or Thimet 10G at 4.5 to 7.0 kg/ac (60 days).

Although not specifically registered for thrip control on beans, Phosdrin 60 SN at 180 ml/ac (1 day) should give control if necessary near harvest.

Seedcorn maggot

Small whitish, headless maggots which attack germinating bean seeds and tunnel them out.

Treat seed with diazinon-captan or diazinon-lindane mixtures according to manufacturers' directions or buy pre-treated seed, if available.

Disease control

Bacterial blights

At planting, clean and then disinfect equipment frequently. Use 10% bleach or quaternary ammonium (Hy-X) as disinfectants. Plant only disease free seed. Use Halo-Blight resistant varieties. Use furrow irrigation, if possible and do not work in fields when foliage is wet. Apply Kocide 101 77WP at 0.9 to 1.3 kg/ac (1 day), Chem Cop 53 WP at 2.3 kg/ac (1 day) as soon as symptoms appear. Plow crop debris under promptly and follow a 3 year rotation. Do not apply bean refuse in manure to fields intended for beans prior to planting.

Dry root rot

Plant fresh, vigorous seed. Subsoil heavy clay soils before planting. In fields where root rot is known to be a problem, cultivate and fertilize to obtain maximum growth. Plow down crop refuse promptly after harvest. Follow a long rotation with cereals, beets, onions or corn. Varieties vary from very susceptible to moderately resistant. Most of the common varieties are intermediate in tolerance.

Gray mold

Maintain air circulation through the plant canopy. Provide good weed control and avoid dense, lush growth. Avoid long periods of overhead irrigation, particularly during flowering. Apply Botran 75 WP at 1.3 kg/ac (2 days), or Benlate 50 WP at 0.9 kg/ac (14 days), or Rovral 50 WP at 0.6 kg/ac. Thorough coverage of blossoms is essential. In fields where Benlate has been used extensively in the past, poor control may result because of a high level of tolerance in the gray mold fungus.

Mosaics

If common mosaic virus is a problem, use resistant varieties. Avoid bean yellow mosaic by planting beans at least 1 km (0.5 mile) away from sweet, crimson or red clover or gladioli which may carry the virus. Control aphids to limit virus spread.

Rust

Plow under crop refuse after harvest. Follow a 3-year rotation. Most bush beans are resistant to rust. Where early infections occur, apply sulphur 92 WP at 2.7 to 3.6 kg/ac (1 day) at 7-day intervals up to blossoming.

White mold (stem and pod rot)

Rotate with beets, onions, spinach, corn, cereals or other grasses. Keep above ground foliage as dry as possible. Avoid dense foliage by restricting levels of soil moisture and nitrogen. Do not sprinkle irrigate in late afternoon or evening. Use furrow irrigation, if possible. Apply Benlate 50 W at 0.7 to 0.9 kg/ac (14 days) or Botran 75 WP at 1.3 kg/ac (2 days) just before full bloom. Cover blossoms thoroughly.

Storage and handling

Snap beans, if cooled immediately after harvest and held at 7°C, can be stored for 8-10 days; humidity should be maintained at about 90%. Beans are subject to chilling injury, and temperatures below 7°C should be avoided. DO NOT top-ice beans. Beans should be properly hydrocooled to remove field heat after harvest.

Grade and packaging standards

There are no federal grade or packaging standards for fresh market beans in Canada. Growers should only market fresh beans free from disease, insects or injury.

Process beans are graded according to federal standards and standards set by individual processors. Contact processors for grade requirements of beans.

BEETS

Varieties

Fresh market: Ruby Queen, Brigadier, Vermilion (round); Formanova (cylindrical).

Process market: as required by processor.

Seed treatment

Purchase treated seed or treat seed with Captan or Thiram.

Seeding and spacing

Seed when soil temperature is over 4°C. Optimum range for germination is 10-24°C. Sow bunch beets at bi-weekly intervals. Plant 1-2 cm (0.5-.75 in.) deep. Space rows 30-40 cm (12-16 in.)

apart and set seeder to give a final in-row spacing of 5-8 cm (2-3 in.). Double line seed rows should be planted if a belt type seeder is used. Between-row spacing must be adequate to allow for a mechanical harvester if one is to be used.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Broadcast and work in 70 to 90 kg/ac of 11-55-0 and 90 kg/ac of 34-0-0 or the equivalent.

Side dress with about 10 to 15 kg/ac of nitrogen during the growing season. Apply 35 to 45 kg/ac of 34-0-0.

Weed control

See weed control table at bottom of page.

Important Note: Do not seed red beets where Trifluralin, Rival or Triflurex was applied in the previous year.

Disease control

Damping-off, blackleg

Sow into a firm, moist seedbed. Treat seed with Captan, Thiram, Dexon or Dexon + Terrachlor dusts. Follow manufacturer's directions.

Storage and handling

Beets intended for storage should be harvested when roots are mature. Damaged and misshapen roots should be discarded. A temperature of 4° to 5°C and a relative humidity about 95% should be maintained. Beets will store up to 4 or 5 months under these conditions.

Bunched beets are often harvested before they reach full maturity. They are not held for long periods in storage although they can be held for 10 to 14 days at 0°C and high relative humidity. Generally, bunched beets should be harvested as close to sale as possible.

Grade and packaging standards

The following is a guide and has no offical sanction.

The grades for beets are Canada No. 1 and Canada No. 2. Canada No. 1 beets have similar varietal characteristics, are not soft or shrivelled, are trimmed so that 75% of the tops do not exceed 1 cm (0.5 in.) and the remainder are not longer than 2.5 cm (1 in.); are free from decay and defect and are reasonably clean. They must have a minimum diameter of 3.2 cm (1.25 in.) and a maximum diameter of 7.6 cm (3 in.). A minimum diameter of 2.5 cm (1 in.) is allowed if that size is clearly marked on a transparent package or the beets are in a bulk display. Canada No. 2 beets have less stringent size requirements. General tolerances exist for both grades.

Beets grown for processing are graded to standards set by individual processors and are usually identified in contracts.

Package sizes for table beets are 907 g (2 lb), 2.27 kg (5 lb) bags and 22.7 kg (50 lb) bags or cartons.

Herbicide Trade Name (genetic name)	Rate (product per acre)	Remarks
Ro-Neet 7.2 E (720 g/l cycloate	1.9 - 2.5 L	Incorporate into soil immediately after application. Ro-Neet does not control weeds of the mustard family.
Pyramin FL (340 g/l pyrazon)	3.3 - 4.1 L	Apply and incorporate in spring before seeding or apply after seeding (pre-emergence) of beets and weeds. At least 1.3 mm rain or irrigation is required for activation of pre-emergence application. Do not use on soils with less than 2% organic matter.

CABBAGE, CAULIFLOWER, BROCCOLI, BRUSSELS SPROUTS (COLE CROPS)

Varieties

Cabbage (green):

Earliest - Polar Green, Tastie Hybrid, Quickstep.

Early - Headstart, Princess, Copenhagen Market Early.

Mid - Guardian, Grand Prize, Blue Boy, Market King, Blue Crown, Prime Pack, Market Prize.

Late - Brutus, Lennox, Bislet, Muliton.

Red:

Early - Ruby Ball, Red Debut, Meteor.

Late - Red Head, Storage Red.

Savoy:

Canada Savoy, Savoy Queen.

Sauerkraut:

Jumbo, King Cole, Canada Kraut.

Chinese Cabbage:

Summertime - Arcadia, China Pride, Green Rocket, Nagaoka 60.

Cauliflower:

Early - Siria, White Sail, White Fox, Starbrite, Goodman.

Late - White Rock, White Top, Andes, Silver Star.

Broccoli:

Mercedes, Green Comet, Premium Crop, Green Surf, Galaxy, Brigadier, Embassy, Cruiser.

Brussels Sprouts:

Oliver.

Seed treatment

Cole crop seed must be hot water treated to prevent black leg and black rot and should be purchased as such. If hot water treated seed is not available, follow hot water treatment recommendations outlined in Section 3 of this guide. Seed should be treated with Captan, Thiram or Streptomycin (Agri-mycin-17) seed treatment.

Young seedlings grown for transplanting should be grown in fumigated soil or seedbeds. (See Asparagus - crown rot.)

Seeding and planting

All cole crops except Brussels sprouts and late cabbage can be direct seeded in the field in most areas of the province. Brussels sprouts require transplanting in all areas and late cabbage requires transplanting in central and northern regions to reach maturity before frost.

Cole crops transplant well and there are several advantages to starting plants early and transplanting into fields. The biggest advantage is early harvesting.Normally, transplanted plants are harvested 3-4 weeks earlier than those direct seeded in the field. Growers are assured of near perfect stands of uniform crops. The cole crops tend to be more uniform in shape, size and maturity. Good transplants also provide some degree of flea beetle control as they will withstand flea beetle attacks without being killed.

Cole crops are cool season plants and will germinate at relatively low temperatures (10°C). Emerged seedlings and well hardened transplants are frost tolerant. Normally, cole crops can be field seeded between April 25 and May 15, depending on location. Plants grown for transplants should be started about 4 to 5 weeks before field setting (approximately April 1-15). Brussels sprouts transplants require about 6 weeks.

Chinese cabbage is sensitive to extreme heat and should be planted early as transplants or seeded in mid-April or late June. Transplants should mature prior to extreme summer heat and both early and late seeded crops will mature in cooler spring and fall temperatures.

Plant cole crops 1-2 cm (0.5-0.75 in.) deep.

110-140 g of seed will provide enough cole crop transplants for 1 acre, 0.8 kg/ac will be required for direct seeding. About 0.2 kg/ac of seed will be required if a precision seeder is used.

More detailed information on production of cole crops is available in a factsheet titled *Commercial Cole Crop Production in Alberta* , FS 252/20-1.

Spacing

Early Cabbage

- Rows 60-75 cm (24-30 in.) apart
- Plants 25-35 cm (10-14 in.) apart

Late cabbage and brussels sprouts
- Rows 60-90 cm (24-36 in.) apart
Plants 40-50 cm (16-20 in.) apart

Cauliflower
- Rows 60-90 cm (24-36 in.) apart
Plants 30-45 cm (12-18 in.) apart

Broccoli
- Rows 45-75 cm (18-30 in.) apart
Plants 30-45 cm (12-18 in.) apart

Chinese cabbage
- Rows 60-75 cm (24-30 in.) apart
Plants 30-45 cm (12-18 in.) apart.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Before planting, broadcast and work in up to 70 kg/ac of 11-55-0 and 45 kg/ac of 34-0-0 or the equivalent.

Apply an additional 14 to 16 kg/ac of nitrogen as a side-dress application or through the irrigation system about one month after seeding or planting. Apply 45 kg/ac of 34-0-0.

If transplanting, apply 280 ml (4 fl oz) of the following solution to each plant: 4.5 kg (4 lb) of 10-52-10 (or equivalent) in 560 L (50 gal) of water.

Weed control

Members of the mustard family (e.g., stinkweed, shepherd's-purse) cannot be chemically controlled in cole crops and adequate crop rotation in previous years or cultivation in the growing season will be required to control these weeds.

Treflan 545 EC or Rival 500 EC a preplant incorporated treatment for use in transplants of broccoli, brussels sprouts, cabbage and cauliflower and direct-seeded cabbage and cauliflower has registration pending approval under the Minor Use of Pesticides Program. The application rates, incorporation instructions, etc. are the same as those listed under "beans".

Excel (90 g/L fenoxaprop-ethyl) at 1 L/ac controls certain grasses (see table 7) in broccoli, cabbage and cauliflower. Interval between application and harvest must be at least 60 days. Water volume of 40 L/ac and spray pressure of 275 kPa is required. Apply spray at a 45° angle forward for better spray coverage. Weeds should be actively growing.

Cole crops are particularly sensitive to residues of linuron (Lorox, Afolan) and metribuzin (Sencor, Lexone). In situations where applications of any of these products occurred late the previous season, growers should rotate to other crops.

Insect control

Because of the waxy leaves, use a spreader-sticker with all insecticide sprays on cole crops.

Aphid

Powdery, greenish-grey species on leaf undersides or on stems. Check plants frequently and alternate between chemical groups to help prevent resistance build-up. Apply one of the following sprays:

a) Early season, 2-3 weeks control.

Cygon 4E, (Lagon, System) 48 EC at 225 to 400 ml/ac (Broccoli, Cabbage, Cauliflower - 4 days, Brussels Sprouts - 21 days) - Repeat as necessary, or Systox 24 EC at 0.90 L/ac (21 days).

Alternative chemicals and formulations: Systox 72 EC (21 days); Di-Syston 15G, 72 EC (30-42 days); Metasystox-R 24 EC (21-24 days).

b) Mid season, 7-10 days control.

Monitor 480 48 SN at 445 to 930 ml/ac (Cabbage, Cauliflower - 7 days, Broccoli, Brussels Sprouts - 14 days). Repeat at 7 day intervals, or Thiodan (Endosulfan) 4E 40 EC at 565 to 850 ml/ac (7 days). Apply at temperatures over 22°C.

Alternative chemicals and formulations: Thiodan 50 WP (7 days); Diazinon 50 WP, 50 EC (5-14 days); Guthion 50 WP, 12 EC, 24 EC (7-21 days).

c) Late season, less than 1 weeks' control.

Phosdrin 60 SN at 180 ml/ac (Broccoli, Cabbage - 2 days, Brussels Sprouts, Cauliflower - 3 days), or Malathion 50 EC at 0.5 to 1.0 L/ac (Broccoli - 3 days, Cabbage, Cauliflower, Brussels Sprouts - 7 days). Use at temperatures above 21°C.

Alternative chemicals and formulations: Malathion 85 EC, 4 DU (3-7 days); Dibrom 86.4 EC (4 days); Rotenone 1 DU (1 day).

Cabbageworm, cabbage looper, diamondback moth

Green caterpillars either large and velvety-green or small and wriggling. They feed on undersides of leaves producing holes. Check plants frequently and treat when damage first observed or soon after white butterflies or diamondback moths are observed in the crop. Alternate between chemical groups to help prevent resistance build up.

Apply one of the following foliar sprays:

Monitor 48 SN at 445 to 930 mL/ac (Cabbage, Cauliflower - 7 days, Broccoli, Brussels Sprouts - 14 days) - Repeat at 7 day intervals, or

Lannate L, (Nudrin) 21.6 SN at 445 to 910 ml/ac (Cabbage - 1 day, Broccoli, Brussels Sprouts, Cauliflower - 7 days), or

Phosdrin 60 SN at 180 ml/ac (Broccoli, Cabbage - 2 days, Brussels Sprouts, Cauliflower - 3 days). In subsequent applications use half the rate,

or Thiodan 4E, 40 EC at 565 to 850 ml/ac (7 days) - Apply at temperatures over 22°C, or

Belmark 30 EC at 60 to 130 mL/ac in 140 to 220 L water/ac (14 days). Do not use a wetting agent when applying Belmark to cabbage, or

Decis 5 EC at 60 to 80 ml/ac in 140 to 220 L water/ac (7 days), or

Ambush 50 EC at 30 to 60 ml/ac in 160 to 270 L water/ac (Cabbage, Cauliflower, Brussels Sprouts - 3 days, Broccoli - 7 days), or

Dipel at 45 to 110 g/ac. No time restrictions. Use 220 to 445 g/ac for cabbage looper. Apply when caterpillars are small. Allow 3 to 4 days for mortality to occur.

Use Belmark, Ambush and Decis at cooler temperatures and for larger caterpillars.

Alternative chemicals and formulations: Pounce 38.4 EC (3-7 days); Sevin 50 WP, 80 WP, 43 SU (3 days); Guthion 50 WP, 12 EC, 24 EC (7-21 days); Malathion 4 DU, 50 EC, 85 EC (3-7 days); Methoxychlor 50 EC (3-14 days); Dylox 80 SP, 42 EC, (21 days); Dibrom 86.4 (4 days); Rotenone 1 DU (1 day), Counter 15-G (0 days).

Cutworm

Usually red-backed cutworms which cut off young plant at base.

Apply one of the following:

Lorsban 4 E, 48 EC at 970 ml in 80 to 160 L of water/ac (P). Apply once to soil 3-7 days before planting or transplanting. Do not incorporate, or

Lorsban 25 WP at 0.9 to 1.8 kg/ac in 80 to 160 L of water) (32 days). Apply at 2 to 5 leaf seedling stage only.

Flea beetle

Small black or black and yellow jumping beetles attack seedlings at pre-emergence and post-emergence stage, chewing notches in stems and shotholes in cotyledons and leaves. Early protection is essential for cole crops in most areas of Alberta, particularly in precision seeded crops.

Apply one of the following as a foliage spray and repeat as necessary at one or two week intervals as necessary until plants are well established.

Thiodan 4E, 40 EC at 565 to 850 ml/ac (7 days). Apply at temperatures over 22°C or

Sevin 50 WP at 445 to 930 g/ac (3 days).

Alternative chemicals and formulations: Sevin 80 WP, 43 SU (3 days); Di-Syston 15 G, 72 EC (30-42 days); Methoxychlor 50 EC (3-14 days); Rotenone 1 DU (1 day); Ambush 50 EC (3-7 days).

In 1985 trials in the Edmonton area, Dasanit 15 G, registered for root maggot control, gave good protection of seedlings from flea beetles.

Thrips

Tiny, various colored insects which sometime become a problem after cabbage head formation. They feed under wrapper leaves, rasping tissue to leave oedema-like symptoms. They are worse in hot, dry weather.

Apply one of the following as a foliar spray as soon as heads begin to form and repeat at weekly intervals as necessary.

Phosdrin 60 SN at 180 ml/ac (450 ml/ha) (Broccoli, Cabbage - 2 days, Brussel Sprouts, Cauliflower - 3 days or

Rotenone 5 WP or 5 DU at 4 to 5 kg/1000 L (4 to 5 lb/100 gal) of water (1 day).

Cygon, Decis and Lagon 480E, registered on cole crops for other pests, have given some protection also.

Root maggot

Gray-black flies lay eggs at the base of the plant from late May to late June. Plants as young as 2 to 3 leaf stage may be attacked. A second generation emerging in mid to late July may lay eggs in the heads of some types of cole crops. A single early season treatment is normally adequate to protect roots of cole crops from significant damage.

Apply one of the following materials: Pre-seeding and pre-transplanting:

Dasanit 15 G at no more than 7.6 kg/ac or 125 g/100 m (1.5 oz/100 ft) of row (40 days). Apply in a 15 cm (6 in.) band prior to seeding or transplanting. Cultivate into top 2.5 cm (1 in.) of soil. Make a second application 14 days later using Dasanit 72 EC (see later) or

Counter 15-G. Apply at seeding time, placing granules in a 15 cm (6 in.) band over the row and incorporating shallow for early season infestation. Late season infestations will require supplemental control measures or

Diazinon 5 G at 150 g/100 m (1.6 oz/100 ft) of row. Apply in furrow at seeding.

Post-seeding or post-transplanting:

Dasanit 72 EC at 25 ml in 10 L water/100 m of row (1 fl. oz. in 20 pt. of water/100 yds. of row) to a maximum of 1.7 L/ac (40 days). Drench within 3 days of transplanting or 7 to 10 days after seeding (if granular treatment was applied) or

Lorsban 4 E at 1.4 L/ac in 400 L/ac water at 1.4 L/ac for 60 cm row spacing and 2.8 L/ac (8 L/ha) for 30 cm row spacing. Apply 10 cm on either side of the plant 7-10 days after seeding or 3 days after transplanting (Chinese Cabbage, Broccoli, Cabbage, Cauliflower, Brussels Sprouts - 32 days or

Lorsban 25 WP at 1.25 to 1.3 kg/ac (32 days). Use only on cabbage as a transplant treatment at 200 ml solution per plant or

Diazinon 5 G at 80 g/10 m (1 oz/10 ft) of row within a 10 cm (4 in.) radius of each plant or

Guthion 50 WP at 1 kg/1000 L (1 lb/100 gal). Apply at 160 ml (7 fl oz) per plant at or immediately after transplanting. (Brussels Sprouts - 7 days, Broccoli, Cauliflower - 15 days, Cabbage - 21 days).

Alternative chemicals and formulations:

Guthion 24 EC. In 1986 trials in the Edmonton area, Lorsban and Dasanit 15 G and 72 EC gave poor root maggot control while Lorsban 4E gave good control.

Disease control

Blackleg

Use clean seed or hot water treated seed (see Section 3 on Seed treatment) or purchase seed treated with Thiram or Captan. Eradicate cruciferous weeds. Use a four year crop rotation with non-cruciferous crops. Maintain good soil drainage. Plow down all crop residue.

Black rot

Use clean seed or seed treated with Streptomycin or in hot water (see Section 3 on Seed treatment). Use a two-year rotation without crucifers in the production fields. Use a three-year rotation on transplant beds. This latter practice is important because spread of disease occurs mostly in the seedbed. Check seed catalogues for reference to disease resistance. Sprinkler irrigation and working in wet fields helps spread infection.

Sclerotinia rot (drop or watery soft rot)

Rotate with crops such as grasses, cereals, beets, onions, spinach or corn. Plant in well-drained soil. Use a plant spacing that will allow good air circulation among plants. Practise good field sanitation (remove and destroy diseased plants). Disinfect storage bins prior to harvest using steam, copper sulphate at 1 kg/50 L (2 lb/10 gal) of water, or formaldehyde 37% SN 2.5 L/100 L (2.5 gal/100 gal) of water. Storage areas must be allowed to aerate until odor is gone before storing produce.

Soft rot

Avoid mechanical injury during cultivation and harvesting. Use plant and row spacings that will allow for good air circulation. Prolonged overhead irrigation may increase infection. Control root maggots, slugs and chewing insects. Avoid excess nitrogen. Minimize frost injury. Disinfect storages (see Sclerotinia rot) and maintain proper temperature and adequate air flow in storage.

Wirestem, damping-off

Do not plant in cold, moist soils. Avoid excessive irrigation. Grow transplants in fumigated seedbeds (see Asparagus-Crown rot). Space seedlings in seedbeds to allow air circulation around plants. Dust seed with Captan or Thiram prior to planting.

Special problems

Cauliflower blanching

It is imperative to market only white compact heads of cauliflower. Heads that develop during hot weather and are exposed to sunlight become yellow and unmarketable. There are three methods that can be used to help reduce yellowing.

a) Use recommended varieties. A criterion used in selecting cauliflower varieties is the ability of the plant to protect the heads with leaves and produce a white curd.

b) Tying heads. When the head is small it is well covered by leaves. As the head expands the covering leaves are pulled away and the head becomes exposed. The large outside leaves of the

plants can be tied over the small head. Since plants will be ready for tying at different times, use different colored string on each day. A few plants of one color string can be checked and if mature the entire lot can be harvested without checking each plant. Head tying works well, however, it is not practical on large plantings as it is very labor intensive.

Breaking two or three of the larger inside leaves over the head is quicker than tying, however, it is not generally satisfactory.

c) Crowding plants. An alternative method of helping to produce white curds is to reduce the between-row and in-row spacings. By planting cauliflower in rows of 60 cm (24 in.) apart and spacing plants 25-30 cm (10-12 in.) apart in the row, the outside leaves will tend to grow in a more upright position. This more intensive upright leaf growth shades the developing curds more than if the plants are farther apart, however, crowding can delay maturity, reduce head size, and may promote disease. This method is recommended on a trial basis.

Brussels sprout development

Only a few varieties are recommended for Alberta because they require a relatively long growing season. Because of Alberta's short growing season, even recommended varieties will not produce well in some years. The development of sprouts can be improved by pinching the growing point of the plants when the middle sprouts are about 1-2 cm (0.5-.75 in.) in diameter (early August). This also improves uniformity and promotes maturity, which is desirable for a single harvest.

Cabbage splitting

Cabbage splitting can be largely overcome by using recommended varieties and maintaining uniform soil moisture. However, knowing when the crop is mature and harvesting it at that time is the best prevention. Varieties are selected, in part, for their lack of splitting at maturity, and for the length of time they will remain whole after reaching maturity. Splitting may result from rain or irrigating a dry soil close to the maturity date. This causes rapid growth after a period of slow growth, and results in splitting. One method of partially controlling splitting is by deep cultivation to prune roots and reduce water uptake. This method is difficult and may result in some mechanical damage if not done carefully. Proper irrigation should prevent most splitting. Uneven maturity resulting from uneven germination and growth--uneven or poor irrigation, insect and mechanical damage--will increase the risk of splitting if the crop cannot be continually harvested as the plants mature.

Since splitting can be overcome by harvesting when the crop is mature, knowing when to plant the crop can also be important. For example, it would not be wise to field set transplants of a storage variety on April 15. The variety would probably mature before common storages are cool enough. Plant early, mid-season and late varieties in that order.

Cabbage maturity

Maturity of cabbage is determined by the firmness and density of the heads and by the size characteristic of that variety. Late storage cabbages should be hard and dense, but the outer head leaves should not be cracking nor the head starting to split. Heads of early and mid-season varieties of green cabbage and savoy cabbage are firm at maturity but do yield to moderate pressure when squeezed.

Cauliflower and broccoli maturity

The maturity of cauliflower and broccoli should also be determined by the firmness and compactness of the heads--not so much by their size. Heads of both should be full, firm and compact. Cauliflower heads should be deep.

Heads must be harvested when they reach this stage. Both broccoli and cauliflower heads become unmarketable very quickly. Hot weather hastens over maturity. Broccoli florets become loose, stalks elongate and flowers start to develop. Cauliflower curds separate, become uneven and 'ricey'.

Storage and handling

Cole crops should generally be stored at 0°C and more than 95% relative humidity. Only mature, disease-free specimens should be stored.

Broccoli has a storage life of approximately 1 week. Storage life can be increased by using nonperforated poly bags.

Brussels sprouts have a storage life of 3 to 4 weeks at 0°C and a high relative humidity; sprouts will also benefit from storage in poly bags.

Cauliflower is not usually stored; it can, however, be held for up to 2 weeks at 0°C.

Early cabbage generally is not stored; if necessary it can be held for 3 to 4 weeks.

Late cabbage can be successfully stored for 5 to 6 months at 0°C and high humidities. Cabbage may be stored in bulk or in tote bins. Depth of bulk stored cabbage should not exceed 2-3 m (6-8 ft).

Adequate ventilation is required. Varieties vary considerably in their ability to retain a green color. (See variety recommendations.)

Grade and packaging standards

The following is a guide and has no official sanction.

Cabbage

Grade classes for cabbage are Canada No. 1 and Canada No. 2. Canada No. 1 grade cabbage has similar varietal characteristics, has heads that yield only slightly to pressure, except the savoy type which must have heads that are not soft; are trimmed so that butts are not longer than 1.2 cm (0.5 in.) with all outer leaves injured by insects, disease or mechanically removed and have no more than 6 wrapper leaves per head; are free from heads that are split or show the formation of the seed stalk; are free from decay; are free from injury or defect that materially affects the appearance, edibility or shipping quality; that do not vary more than 5 cm (2 in.) in diameter when packaged.

Canada No. 2 cabbage is similar to Canada No. 1 except that the injury and defect tolerance is increased to 15% of the edible portion of the head.

General tolerances allow that 10% of packages may contain heads that exceed the permitted size variation; 2% of the heads by count may be affected by decay; 5% of the heads by count may have the same grade defect; 10% of the heads by count (including the 2 and 5% previously indicated) may have grade defects and still meet the grade standards for Canada No. 1 and No. 2 cabbage.

The package sizes for cabbage are: 18 kg (40 lb) and 22.7 kg (50 lb) bags or cartons and 11.3 kg (25 lb) for Alberta only.

Cauliflower

Grades for cauliflower are Canada No. 1 and Canada No. 2. Canada No. 1 cauliflower has compact heads, is fresh with green wrapper leaves; has heads free from abnormal color or riciness; are free from damage and decay; have a minimum head diameter of 10 cm (4 in.), which do not vary more than 5 cm (2 in.) when packaged. Canada No. 2 cauliflower has similar requirements except that there are no size minimums. A series of general tolerances also affect each grade.

There are no official package sizes for cauliflower.

Broccoli

There are no grade standards for broccoli and any designations should be agreed to by the seller and buyer. However, a grower should sell only top quality broccoli; fresh and not wilted; firm and compact heads with no evidence of flowers beginning to open; heads that do not have leaves growing up through the centres; outside leaves removed from the stem; single heads 10-15 cm (4-6 in.) with 15-20 cm (6-8 in.) stem; bunches in 12-15 cm (5-6 in.) bundles with 15 cm (6 in.) stems; uniform bunches not varying more than 5 cm (2 in.). There are no official package sizes for broccoli.

Brussels Sprouts

Generally Canada No. 1 brussels sprouts have sprouts removed from stalk; are not wilted or split and are firm; are green in color (not yellow and discolored); have a minimum diameter of 2 cm (1 in.) and maximum diameter of 5 cm (2 in.); have maximum length of 7 cm (2.75 in.); are free from decay, injury and defects which affect appearance, edibility and shipping quality. Canada No. 2 brussels sprouts have no maximum diameter limits. The package sizes for brussels sprouts are 283 g (10 oz) and 454 g (16 oz) bags or cups.

Carrots

Varieties

Fresh market:
Nantes - Frantes, Lindoro, Nangro, Laranda, Nandor.
Imperator - Apache, Gold Pak 28, Gold Pak 263, Spartan Fancy, Nelson.

Baby carrots: (for bunching, fresh pack or processing) Baby Finger Nantes, Finicor, Touchon Deluxe, Vita Sweet 500, Mini Express, Baby Orange.

Process market: (dicing) As required by processor or Royal Chantenay, Red Cored Chantenay, Chantenay Supreme Long Type.

Seed treatment

Buy treated seed or treat seed with Captan or Thiram as directed by manufacturer.

Soils

Carrots should be grown on a loose, friable, sandy loam soil if possible. However, it is possible to grow carrots on heavier soil if the proper cultural practices are followed. All soil should be well drained.

Because of the rooting habits of this crop and the desirability of producing a high percentage of long, straight smooth roots, the soil should be worked to a minimum depth of 30 cm (12 in.). This allows for unobstructed root extension and development, easy moisture penetration and adequate aeration of the soil. A uniform, well worked seedbed should be prepared before seeding commences.

Seeding

Carrots should not be planted into cold soil as they do not germinate well below 10°C. In the southern regions, carrots are not normally seeded before April 20. Most crops are seeded between May 1 and May 15. In northern areas seeding may be delayed until late May.

When seeding is delayed because of weather, the seeding rates may have to be reduced to allow for roots to develop to marketable size before severe frosts kill the tops.

Carrots are shallow seeded 1-2 cm (0.5-0.75 in.). Germination can be hindered or the crop killed if the soil around the seed dries out. Irrigation in southern areas is normally essential to establish a good stand of carrots. Seeding may have to be delayed until irrigation water is available.

The following are seeding recommendations for fresh market carrots. Growers are recommended to use a belt type seeder equipped with 7 cm (3 in.) triple-line shoes. Belts are punched with three rows of holes. Hole number and size depend on seeding rate required and on the size and shape of the carrot seeds. Carrot seed varies greatly in size, normally ranging from 330,000 to 880,000 seeds/kg (150,000 to 400,000 seeds/lb). Depending on seed size and stand required a grower can expect to use from 0.8 to 3.0 kg/ac of seed. Normal requirements are about 1.2 to 2.0 kg/ac.

Long type carrots grown for storage should be planted to achieve a final stand of about 100 plants/m (30 plants/ft) in a triple-line band 7 cm (3 in.) wide. The centre line of the seed belt should have about 30-50% fewer holes than the outside lines. Long type carrots or Nantes types grown for early bunching or early cellopak trade should be planted to achieve a final stand of 60-100 plants/m (20-30 plants/ft).

Carrots are difficult to germinate on coarse textured mineral soils. Both field conditions (field factor) and per cent germination can greatly reduce the number of seeds planted that will emerge. A normal range for emergence is 40-60%. This means that for every 100 seeds planted about 40-60 carrot plants will become established. As a rule of thumb, use 50% as a guide.

More detailed information on production of carrots is available in a factsheet titled *Commercial Carrot Production in Alberta*, FS 258/20-2.

Row spacing

Row spacing must be compatible with harvest equipment used. Although the mechanical harvester can be adapted to harvest rows as close as 30 cm (12 in.) apart, growers find it difficult to harvest most varieties spaced less than 45 cm (18 in.) apart because the tops between rows tend to bind together. This problem is increased as heavy frosts weaken and drop the tops.

Normally cellopak carrots are grown on single row beds spaced 60 cm (24 in.) on centre. Alternatives include: 3 or 4 rows on beds with 1.8 m (6 ft) centres; or growing two rows on beds with 90 cm (3 ft) centres. Single-row beds 60 cm (24 in.) on centre have 50 cm (20 in.) wide tops and are 15-20 cm (6 to 8 in.) high.

Fertilizer

Growers should always base fertilizer applications on the result of annual soil tests.

Before planting, broadcast and work in 90 to 100 kg/ac of 11-55-0 and 90 kg/ac 34-0-0 or the equivalent.

Broadcast about 15 kg/ac of nitrogen or put about the same amount of nitrogen through the irrigation system during the growing season.

The phosphorus fertilizer may be banded into the seedbed before planting.

Herbicide Trade Name (generic name)	Product Rate (per acre)	Remarks
a) preplant incorporated		
Treflan 545 EC or Rival 500 EC (trifluralin)	0.6 - 0.8 L 0.65 - 0.89 L	Use the lower rate on sandy soils with less than 6% organic matter. Apply in 40 L/ac of water. Incorporate within 24 hours of application into soil in two different directions or in one direction with a rotovator. Incorporation can also be accomplished with a tandem disc, disker or field (vibrashank type) cultivator set to work 8 to 10 cm (3 to 4 in.) deep. As a precautionary measure, do not plant red beets, sweet corn, vine crops, oats and small seeded annual grasses in rotation following use of Trifluralin. Registration is pending.
b) pre-emergence		
Afolan F (450 g/L linuron)	0.56 - 1.1 L	Shake containers with flowable formulations vigorously. Rain or irrigation is required to activate herbicide. Additional postemergence treatments may be required. Apply with at least 120 L/ac of water.
Lorox L (480 g/L linuron)	0.45 - 1.37 L	
Lorox DF (500 g/kg linuron)	0.4 - 1.3 kg	
c) postemergence		
Afolan F (450 g/L linuron)	0.81 - 2.0 L	Spray when carrots have two or more fully developed leaves. Use lower rates on sandy soils. Treatment kills sensitive emerged weeds and suppresses green foxtail. Provides residual control for remainder of season during hot weather. Spray during the cool part of the day to avoid injury. For a combination of pre-emergence and postemergence applications, consult a herbicide label.
Lorox L (480 g/L linuron)	0.91 - 1.82 L	
Lorox DF (500 g/kg linuron)	0.90 - 1.80 kg	
Herbicidal Oil	240 - 325 L	Controls annual grasses, redroot pigweed, lamb's-quarters and purlane in the seedling stage. Apply undiluted as an overall treatment after carrots have developed first true leaves and before roots are thicker than a pencil. Weeds must be small.

Herbicide Trade Name (generic name)	Product Rate (per acre)	Remarks
Hoe Grass (284 g/L diclorfopmethyl)	1.4 L Add assist oil concentrate according to label directions.	Apply in 45 L/ac of water at 275 kPa with spray at a 45° angle forward. Weeds should not be under stress. Water volume required 20 to 44 L/ac. Tilt spray boom forward 45° for better coverage. Treat when grasses are actively growing and at recommended leaf stage. Allow 4 days between application of Poast and any other chemical. Do not allow spray mixture to sit overnight. Addition of ammonium sulphate enhances control. Interval from application to harvest is 60 days.

Insect contol

Leafhopper

The main concern is the aster leafhopper, a small pale yellow leafhopper with black dots and dashes on the head. It transmits aster yellows disease to carrots. In areas where this is a problem (mostly southern Alberta) isolate plantings from forage legume fields, cereal crops and very weedy areas where leafhoppers breed, and rogue infected plants.

If necessary apply one of the following as a foliar spray:

Phosdrin 60 SN at 180 ml/ac (3 days), or

Sevin 50 WP at 445 to 930 g/ac (1 day), or

Methoxychlor 50 WP at 3.7 to 2.0 kg/1000 L water/ac (7 days).

Alternative chemicals and formulations: Sevin 80 WP, 48 SU, 43 SU (1 day); Methoxychlor 24 EC (7 days).

Disease control

Aster yellows

Isolate carrot plantings from forage legume fields and rough weedy areas where leafhoppers may abound. Remove infected plants as soon as detected, if practical. Control leafhoppers in fields and perimeter areas (see Insect control).

Leaf blight and leaf spot

Rotate crops and practice good field sanitation. Apply Bravo 500 at 0.9 to 1.3 L/ac (1 day), Dithane M-45 or Manzate 200 at 0.9 kg/ac (7 days) or Zineb 80 WP at 1.3 kg/ac (7 days) at the first signs of infection and repeat every 7-14 days as necessary. Plow all crop refuse under after harvest.

Rubbery root

Provide adequate drainage in the field. Harvest as soon as the carrots are mature. Storages should be well ventilated and disinfected between crops (see Cole crops - sclerotinia rot). Rotate with cereals or grasses.

Soft rot

Harvest and handle the crop carefully to avoid bruising. Cull rotted roots before storage. Allow roots to dry before storing. Store under cool (0-1°C), humid (90-95% RH) conditions with adequate aeration. Disinfect storages between crops (see Cole crops - sclerotinia rot).

Sclerotinia rot (white mold)

Rotate with resistant crops such as grasses, cereals, beets, onions, spinach or corn. Plant in well-drained soil. Use a plant spacing that will allow good air circulation among plants. Practise good field sanitation (remove and destroy diseased plants). Disinfect storage bins prior to harvest. (See Cole crops - sclerotinia rot). To control the disease in storage, spray or dip washed or unwashed carrots, either before or during the storage period with Benlate 50 WP at 0.5-1.0 kg/1000 L (1.2-2.0 lb/500 gal) of water.

Storage and handling

Mature topped carrots store well for 5 to 6 months when held at 0°C and more than 95% relative humidity.

Quick removal of field heat will lengthen the storage period.

Bacterial soft rot and white mold can cause serious losses in storage. (See Disease control)

Grade and packaging standards

The following is a guide and has no official sanction.

The grades for carrots are Canada No. 1, Canada No. 1 - cut crowns and Canada No. 2.

Canada No. 1 carrots have similar varietal characteristics; are not woody, soft or shrivelled; are trimmed so that 75% of the tops do not exceed 1.2 cm (0.5 in.) and the remainder do not have tops more than 2.5 cm (1.0 in.); are not rough or misshapen; are clean; are free from sunburn that extends more than 1.2 cm (0.5 in.) below the crown or affects more than 10% of the carrots in the lot; are free from decay and damage; are free from injury and defect that affects appearance, edibility or shipping quality or that cannot remain without the loss of more than 5% of total weight; have a minimum length of 11 cm (4.5 in.) and have a minimum and maximum diameter as marked on a package, however, the minimum diameter cannot be less than 2 cm (0.75 in.). Freedom from damage is specifically defined for this grade; crown damage cannot exceed 1.2 cm (0.5 in.) in depth, be discolored or exceed 2/3 the diameter of the carrot; broken carrots must be 15 cm (6 in.) in length and have a tip diameter greater than 1/2 the diameter of the carrot; fresh cracks must be clean, not over 3.3 mm (1/8 in.) wide, not over 6.3 mm (1/4 in.) long or exceed 1/3 the length of the carrots.

Canada No. 1 - cut crowns are carrots that have crowns or shoulders removed but in every other way meet the requirements of the Canada No. 1 grade.

Canada No. 2 carrots are similar in grade requirements to Canada No. 1 except that injuries and defects are allowed up to 10% of the total weight.

The word "washed" can be used in connection with any of the grades provided the carrots have been washed before packaging.

The following general tolerances are applicable to all carrot grades; 4% of carrots by weight may be below the prescribed or designated minimum size; 8% by weight may exceed the maximum size; 2% by weight may be affected by decay; 5% by weight may have the same grade defect if this defect does not relate to over or under size; 10% of the carrots by weight may have grade defects including those previously listed and still meet grade standards.

The packaging standards for carrots are 907 g (2 lb), 1.36 kg (3 lb), 2.27 kg (5 lb), 4.53 kg (10 lb for Alberta only) consumer sized packages and 11.3 kg (25 lb), 22.7 kg (50 lb) and 34 kg (75 lb) bags for bulk shipping. Master containers for consumer packages are not identified.

CELERY

Varieties

Ventura, Improved Utah 52-70, Tendercrisp.

Seed treatment

Use hot-water treated seed. Buy treated seed or treat seed with 75% Thiram following manufacturer's recommendations.

Seeding and planting

Sow seed in the greenhouse about 10 weeks before transplanting into the field. Transplant to the field when there is no risk of prolonged temperatures below 13°C, because low temperatures induce bolting. Harden plants by the use of water withdrawal, not by the use of cold temperature. 225 g seed should grow enough transplants for one acre. Until plants emerge, a temperature in the greenhouse of 21-24°C is suitable. The 18-24°C is ample for steady growth. Do not drop night temperatures below 13°C.

If plants are too tall at time of transplanting, they can be clipped back to 12-15 cm (5-6 in.); this may result in checked growth.

Spacing

The use of transplant machines limits the plant spacing used. Space plants 15-20 cm (6-8 in.) apart within rows that are 60-90 cm (24-36 in.) apart.

If celery is planted by hand, reduce between-row spacing to 45 cm (18 in.).

Fertilizer

Growers should always base fertiiizer applications on the results of annual soil tests.

Before planting, broadcast and work in up to 100 kg/ac of 11-55-0 and 55 kg/ac of 34-0-0, or the equivalent.

Four to six weeks after planting, apply 10 to 15 kg/ac of nitrogen as a sidedressing application. The nitrogen can also be applied through the irrigation system. Do not allow granular fertilizer to become lodged in the stems and leaves of the celery plants because burning can result.

Weed control

Afolan F (450 g/L linuron). Apply 0.8 to 2.0 L/ac in 80 to 160 L/ac water after celery transplants are established, but early postemergence to weeds. Some temporary discoloration of the crop may occur.

Herbicidal Oils 240 to 325 L/ac as an undiluted spray before hearts form or before plants are over 15 cm (6 in.) tall and when weeds are small.

Insect control

Aphids

Small green species clustered on leaves and stalks and in crowns. Spray into crowns at not less that 690 kPa (100 psi) pressure.

Apply one of the following as a foliar spray:

Malathion 50 EC at 810 ml/ac (2.0 L/ha) (7 days), or

Dibrom 86.4 EC at 445 to 670 ml/ac (1.1 to 1.65 L/ha) (4 days), or

Thiodan 4E, 40 EC at 850 ml/ac (2.1 L/ha) (14 days).

Alternative chemicals and formulations: Malathion 25 WP, 85 EC (7 days); Dibrom (Bromex) 65.4 EC; Thiodan 50 WP (14 days); Phosdrin 60 SN (3 days); Systox 24 EC, 72 EC (28 days).

Disease control

Aster yellows

See Carrots - Aster yellows.

Black heart

Maintain uniform soil moisture. Avoid heavy applications of high salt index fertilizers. Apply calcium nitrate (20% Ca) at 1 to 2 kg/100 L (10 to 20 lb/100 gal) of water or calcium chloride (36% Ca) at 0.5 to 1.0 kg/100 L (5 to 10 lb/100 gal) every 7-10 days as a foliar application during warm, cloudy periods when the disease may occur.

Special problems

Celery plants must be provided with constantly uniform high levels of soil moisture. Regular irrigation in most areas is essential to produce celery that is tender and free from "stringiness". Refer to Section 5 of this publication on irrigation requirements of celery.

Storage and handling

Celery should be stored at 0°C and more than 95% humidity.

When held at these conditions, a storage life up to 3 months can be expected although celery is extremely sensitive to moisture loss.Storage in perforated plastic bags is of value.

Hydrocooling or vacuum-cooling is recommended when celery is marketed from the field.

Grade and packaging standards

The following is a guide and has no official sanction.

The grades for celery are Canada No. 1, Canada No. 1 Heart and Canada No. 2.

Generally Canada No. 1 celery is fresh; is trimmed to remove damaged, coarse or misshapen outside branches; is free from decay, heart rot and stalks that show the formation of seed stems; is free from damage; has stalks of a minimum length of 30 cm (12 in.), a minimum average midrib length of 18 cm (7 in.) and a minimum diameter of 6 cm (2.5 in.) if more than 24 stalks are packed in a package or a minimum diameter of 7 cm (3 in.) if 24 or less stalks are packed in a package; and has packaged stalks that do not vary more than 3 cm (1.5 in.) in diameter or 5 cm (2 in.) in length.

Canada No. 1 Heart possesses the same characteristics as Canada No. 1 except uniformity of size, minimum diameter and minimum stalk length.

Canada No. 2 celery is similar to Canada No. 1, with less specific size requirements except a minimum diameter of 6 cm (2.5 in.).

A series of general tolerances also affect each grade.

There are no official package sizes for celery.

SWEET CORN

Varieties

Fresh market early: (require between 1600 and 1800 Corn Heat Units to mature).
Normal: Earlivee, Sunny Vee, Buttervee, Seneca Horizon, Early King, Northernvee, Spring White.
Super Sweet: Northern Super Sweet, Maple Sweet, Landmark, Extra Early Super Sweet.

Fresh market mid: (require between 1800 and 2000 Corn Heat Units).
Normal: Seneca Gold & Pearl, Early Sunray, Sprite, Earligem, Early Bird, Pilot, Stars-N-Bars.
Super Sweet: Sugar Bun, Sweet Sue, Summer Sweet 724.

Fresh market late: (require between 2000 and 2200 Corn Heat Units).
Normal: Sunburst Improved, Flavorvee, Calypso, Reliance.
Super Sweet: Sugar Loaf, Summer Sweet 7810 & 7620.

Process market: as required by processor.

Seed treatment

Corn seed should be purchased treated with Captan to prevent seed rot during cool spring planting. An additional Diazinon-Lindane seed treatment should be used where necessary to prevent wireworm and seed maggot attacks.

Seeding and spacing

To ensure a continued supply of corn for the fresh market, growers should plant a number of varieties with different maturity dates. Corn should be planted as early as possible but it does not germinate below 10°C. Emerged corn will withstand frost until it reaches about 10 cm (4 in.) in height because the growing tip is below the soil until that stage.

Corn should be planted into moisture, about 3-6 cm (1.5-2.5 in.) deep.

Seeding rates vary from 4 to 7 kg/ac depending on seed size. Growers should try to establish stands of 20,000 to 22,000 plants/ac. Row spacing should be wide enough to allow for a mechanical harvester if one is used.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

If possible, nitrogen applications should be made before planting and again when corn is 30 cm (12 in.) high. When possible phosphorus should be put on before planting and at planting time.

Broadcast and work in before planting, 45 to 70 kg/ac of 11-55-0 and 35 kg/ac of 34-0-0 or equivalent.

At planting time, band 25 to 45 kg/ac of 11-55-0 five cm (2 in.) to the side and 5 cm (2 in.) below the seed.

When the crop is 30 cm (12 in.) tall, sidedress with 35 to 45 kg/ac of 34-0-0 or add 10 to 15 kg/ac of nitrogen through the irrigation system.

Weed control

Weeds in sweet corn may be controlled by two basic methods - cultural and chemical, or by a combination of both.

Cultural Weed Control - The continuous use of the same method of weed control or chemicals can lead to the buildup of weeds that are resistant or tolerant to the control method used. For example, in Ontario triazine resistant lamb's-quarters and pigweed have become a major problem because of repeated use of triazine herbicides in continuous corn cropping. Inter-row cultivation may be required when weeds escape herbicide treatments. Growers should therefore utilize as many options available as possible such as cultivation, crop rotation and usage of different chemicals.

Chemical Weed Control - Growers using atrazine in corn should replant to corn the following two years. The period of atrazine persistence depends on the rate used, irrigation and climatic conditions; carry-over may exceed two years.

When tank mixing atrazine with oil to form an oil-water emulsion, it is important to follow the proper mixing procedure. When filling the spray tank with water, sufficient space should be left for the atrazine and oil. The agitation system should be engaged and then add the atrazine added to the spray tank. The emulsifiable oil or oil concentrate should be added last.

Growers should note that some products control grasses only, eg. Dual & Sutan + , whereas others control broadleaf weeds only, eg. Pardner, Torch, Kil-Mor, Buctril-M and 2,4-D. In many instances, a satisfactory weed control program can be formed by selecting the required herbicides for a tank-mix or following with a postemergence herbicide after the use of preplant incorporated and pre-emergence treatments.

Herbicides for Use in Sweet Corn and Weeds Controlled.

Herbicide	Method of Application	Annual Broadleaved: Wild Buckwheat	Chickweed	Corn Spurry	Flixweed	Common Groundsel	Hempettle	Henbit	Kochia	Lamb's Quarters	Mustard Wild	Hairy Nightshade	Redroot Pigweed	Common Purslane	Smartweeds	Stinkweed	Russian Thistle	Annual Grasses: Barnyard Grass	Green Foxtail	Wild Oats	Volunteer Cereals	Perennials: Canada Thistle	Field Bindweed	Sow Thistle	Quackgrass
Atrazine/Aatrex	PPI	R								R	R		R	R	R	R		R		R	R				
Bladex	PPI/pre	R							R	R	R		R	R	R	R	R	R	R						
Atrazine + Dual	PPI									R	R		R	R	R	R		R	R	R	R				
Primextra	PPI	R								R	R		R	R	R			R	R		R				
Atrazine + oil, Atra-Mix	Post	R								R	R		R	R	R	R			R	R					
Aatrex Plus	Post	R								R	R		R	R	R	R			R	R					
Bladex + oil	Post	R							R	R	R		R	R	R	R	R	R	R						
Dual	PPI																	R	R						
Eradicane	PPI		R	R				R		R	R	R	R	R				R	R	R	R				
Sutan +	PPI																	R	R						
Surpass	PPI									R			R					R	R						
2,4-D amine	Post	S			R					R	R					R	R					S	S	S	
Buctril M	Post	R			R	R				R	R		R		R	R	R					S		S	
Basagran	Post		R	R		R				R	R	R	S	R	R	R	R					S	S		
Laddok	Post		R	R		R				R	R	R	R	R	R		R								
Kil-Mor	Post	R		R	R					R	R		R		R	R	R					S	S	S	
Torch D5	Post	R				R				R	R		R		R	R	R								

R = controlled (registered) S = suppresses growth

Registered Herbicides for Use in Sweet Corn

Herbicide Trade Name (generic name)	Rate (product per acre)	Type of Application	Remarks
Aatrex Liquid 480 (480 g/L atrazine)	0.9 to 1.9 L/ac	PPI, Pre or Post	Postemergence application for control of foxtail should be applied when this weed is in the 1-2 leaf stage. A recommended oil concentrate must be added for postemergence applications when none is present in the formulation. Atrazine is registered for tank mixes with Bladex, Dual, Eradicane and Sutan +. Apply in 60 to 120 L/ac of water. For PPI treatments, incorporate using a double disk or vibrating shank cultivator.
Aatrex Nine-0 (90% dispersible granule)	0.5 to 1.0 kg/ac	PPI, Pre or Post	
Aatrex Plus (400g/L atrazine + 25% oil concentrate)	1.7 to 2.2 L/ac	Post	

Registered Herbicides for Use in Sweet Corn

Herbicide Trade Name (generic name)	Rate (product per acre)	Type of Application	Remarks
Atrazine F (500 g/L)	0.9 L to 1.8 L/ac	PPI, Pre or Post	
Pfizer Atrazine 500 (500 g/L atrazine)	0.8 to 1.8 L/ac	PPI Pre or Post	
Atrazine 90W (90% wettable powder)	0.8 to 1 kg/ac	PPI, Pre or Post	
Atra-Mix (400 g/L + 25% oil concentrate)	1.7 to 2.2 L/ac	Post	
Primextra (atrazine 190 g/L + metolachlor 300 g/L)	2.6 to 3.4 L/ac	PPI PPI	Broadcast and incorporate before planting. Do not use on soils with less than 1% or more than 10% organic matter. Apply in 60-120 L/ac of water.
Dual 960E (metolachlor 960 g/L)	0.8 to 1.1 L/ac		Controls certain grasses. Mix with atrazine or Bladex for broad-spectrum weed control. Can be applied preemergence if irrigated with 10 days.
Bladex Nine-T (90% dry flowable cyanazine)	0.9 to 1.2 kg/ac	PPI, Pre or Post	Registered tank mixes with Atrazine, Dual, Eradicane and Sutan +. For post-emergence applications, add 1 L Bio-Veg T.M. crop oil/100 L solution. Do not apply beyond the 3-leaf stage of corn. Weak for redroot pigweed control.
Bladex Liquid (480 g/L cyanazine)	1.5 to 2.3 L/ac	PPI, Pre or Post	
Bladex 80W (50% cyanazine)	0.9 to 1.4 kg/ac	PPI, Pre or Post	
Eradicane 8E (800 g/L EPTC + R25788)	1.7 to 2.2 L/ac	PPI	Can be tank mixed with atrazine, fluid fertilizers or impregnated on dry fertilizers. Apply in 40 L/ac water or more. Weed control may be reduced if Eradicane or Eptam have been used for two successive years or more. Incorporate into the soil immediately after spraying according to label directions.
Suntan + (800 g/L butylate)	1.7 to 2.2 L/ac	PPI	Can be tank mixed with atrazine or Bladex. Sutan + can be impregnated on dry fertilizer; it can also be

Registered Herbicides for Use in Sweet Corn

Herbicide Trade Name (generic name)	Rate (product per acre)	Type of Application	Remarks
			combined with fluid fertilizers and applied as a spray. Apply in 40-200 L/ac of water. Incorporate immediately.
Surpass (800 g/L vernolate)	1.7 to 2.2 L/ac	Post	Carefully follow soil incorporation instructions on label. Can be tank mixed with atrazine and fluid fertilizers.
2,4-D amine (500 g/L)	200 to 445 ml/ac	Post	Apply as an overall spray until corn is 15 cm high, use drop nozzles for taller corn. Water volume - 40 L/ac.
Buctril M (bromoxynil 280 g/l + MCPA 280 g/l)	400 ml/ac	Post	Can be tank mixed with atrazine but do not add oil concentrate. Apply when corn has 4-6 leaves. Use 80-120 L/ac water volume.
Basagran (480 g/l bentazon)	700 to 900 ml/ac	Post	Add 810 ml/ac Assist Oil concentrate Apply 18-28 days after planting. Use 80-160 L/ac water volume.
Kil-Mor (2,4-D + mecoprop + dicamba)	340 to 445 ml/ac	Post	Overall spray prior to 15 cm ht. of corn, use drop nozzles if crop is taller. Water volume 80-140 L/ac.
Laddok (bentazon + atrazine)	0.8 to 1.6 L/ac	Post	Apply 18-28 days after seeding. Corn tolerant at all growth stages. Assist Oil concentrate at 10 L/1000 L of spray solution is recommended. Water volume 80-160 L/ac.
Torch DS (450 g/L bromoxynil)	250 to 300 ml/ac	Post	Apply when weed seedlings are small (up to 4-leaf stage). Apply alone or tank mix with atrazine until corn is 25 cm tall. Do not add oil concentrate. Water volume 60 L/ac. Some scorching of leaves likely to occur.

Insect control

Corn earworm

Greenish to brownish worms marked with light and dark stripes. Eggs are laid on exposed green silk. Larvae feed on cob. An occasional pest.

Apply one of the following treatments:

Ambush 50 EC at 80 to 180 ml in 130 to 180 L water/ac (1 day). Obtain good coverage of ears and silks, or

Thiodan 4 E, 40 EC at 1.1 L/ac (7 days). Do not ensile or feed crop refuse to livestock. Do not apply more than twice per season, or

Lannate L (Nudrin) 21.5 SN at 0.7 to 1.1 L/ac (3 days). Spray whorls as needed and silks at 2-4 day intervals or as needed.

Alternative chemicals and formulations: Pounce 38.4 EC (1 day); Thiodan 50 WP (7 days); Lannate 90 WP (3 days); Sevin 5 DU, 50 WP, 80 WP, 48 SU (1 day).

European corn borer

Dirty white larvae with small circular patterns which feed both on leaves, stalks and ears. Eggs are laid on the undersides of the leaves. It is serious pest that has gained a foothold in southern Alberta in the last few years. Timing of sprays is critical. Consult labels for details.

Apply one of the following treatments:

Ambush 1 G at 4 kg/ac (1 day). Apply no later than when first feeding is seen on the foliage. Repeat in 5-10 days, or

Ambush 50 EC at 80 to 180 ml in 130 to 180 L water/ac (1 day). Apply no later than when first feeding is seen on the foliage, or

Lannate L (Nudrin) 21.5 SN at 1.0 L/ac (3 days). Spray at 3-5 day intervals as needed.

Alternative chemicals and formulations: Pounce 38.4 EC (1 day); Lannate 90 WP (3 days); Sevin 5 DU, 50 WP, 80 WP, 48 SU (1 day); Furadan 48 SN (7 days); Dylox 80 SP (1 day); Rotenone 1 DU (1 day).

Seedcorn maggot

Small, legless, white fly maggots that chew out seeds and prevent germination.

Apply the following material:

Counter 15G at 75 g/100 m row (0.8 oz/100 ft row) at a minimum 75 cm (2.5 ft) row spacing. Place in 18 cm (7 in.) band over row as directed, at seeding only.

Grasshoppers

Apply the following material:

Furadan 48 SN at 110 ml/ac (7 days).

Disease control

Holcus spot

Follow a two-year rotation that avoids corn, sorghum species, foxtail millet, sudan grass and Johnson grass. Rotate with broadleaf crops. Maintain high levels of potassium. Overhead irrigation increases the chance of disease spread.

Root and stalk rots

Rotate one or more years with broadleaf crops. Reduce plant stress, stalk rot and lodging by limiting plant density to 125,000 plants per acre. Maintain balanced soil fertility. High nitrogen and low potassium levels increase the risk of stalk rot. Plow under old corn stalks and leaves.

Seed rot and seedling blight

Follow a regular crop rotation. Delay seeding until soil temperature is above 10°C. Avoid planting in heavy, poorly drained soils. Treat seed with Captan, Thiram, Dexon, Dithane M-45, Manzate 200 or Pro Gro before planting.

Smut (head and common)

Follow a 4 to 6 year crop rotation with broadleaf crops. Avoid injuring plants during cultivation. Maintain balanced soil fertility avoiding high nitrogen. When practical, remove and destroy diseased plants as they are observed. Clean harvesting equipment thoroughly before entering a clean field. Plant seed treated with carbathiin + thiram.

Special problems

Handling fresh market corn after harvest

During warm weather, sweet corn quality deteriorates very quickly after harvest. The high amounts of sugar in the kernels rapidly change to starch. Sugar levels can start to go down within an hour of harvest and noticeable deterioration can take place within hours. Unfortunately many sweet corn growers do not take simple steps to prevent this problem. Super sweet varieties initially have a much higher sugar content and are therefore "sweeter" tasting over a longer postharvest period.

The complete change-over from sugar to

starch is almost completely stopped if the temperature of the corn is brought down to 2-5°C within an hour of harvest and then maintained at this low level or cooler during shipping and marketing.

The removal of field heat is best done by flushing graded and bagged corn with iced water (0-1°C). This process is called hydrocooling. The key to hydrocooling is using enough ice to maintain low water temperatures and flushing the corn for a long enough time to bring the temperatures down.

Hydrocoolers are commercially available or may be custom made by growers.

Storage and handling

Sweet corn should not be stored, but can be held for shipment for one or two days at 0°C and a relative humidity greater than 95%.

Sweet corn should be hydrocooled to remove field heat and improve quality. (See above).

Grade and packaging standards

The following is a guide and has no official sanction.

The only grade for sweet corn is Canada No. 1. Generally Canada No. 1 sweet corn has similar varietal characteristics; is free from ears that are misshapen; has ears on which the undeveloped ends do not exceed one quarter of the length of the ear; has ears on which the appearance and quality of the edible portion is not affected by poorly developed kernel rows; has ears which have kernels of fairly uniform development; is well covered with fresh unbroken green husks or if the husks have been removed, is protected by transparent wrappers; is free from injury, decay or defect; has a minimum of 10 cm (4 in.) of edible corn on each ear. Packages containing corn must be marked "Canada No. 1 grade Sweet Corn--Small" if ears have a minimum length of 10 cm (4 in.) and a maximum of 15 cm (6 in.) of edible corn.

A series of general tolerances also affect the grade of corn. Units of corn may be packed in 1/2 dozen, 1 dozen and 1 dozen plus multiples of 1/2 dozen in bags, boxes, cartons or crates.

CUCUMBERS, SQUASH, PUMPKIN, MUSKMELON, WATERMELON

Varieties

Pickling cucumbers: Earlipik, Brooks, Pioneer, Cascade.

Slicing cucumbers: Slicemaster, Ultra Slice, Slice Nice.

Summer squash: (most summer squash are bush types)

Green zucchini types - Ambassador, Zucchini Select, Super Select

Yellow crookneck types - Cracker, Dixie

Yellow straightneck types - Goldbar, Goldzini, Smoothie

Patty-pan or scallop types - Scallopini, Early White Bush Scallop

Other summer squash - Vegetable Marrow, Cousa

Winter squash:

Acorn or Pepper type - Table King (bush), Jersey Golden Acorn (bush). Tay-Belle

Buttercup types - Kindred, Buttercup, Sweet Mama

Hubbard types - Golden Hubbard, Baby Hubbard Kitchenette

Delicious types - Golden Delicious, Green Delicious

Ornamental types - Sweet Dumpling

Other winter squash - Vegetable Spaghetti, Banana Squash, Orangetti

Pumpkin:

Normal - Autumn Gold, Jackpot, Jack O'Lantern, Spirit (bush)

Pie - Small Sugar, Spookie (bush)

Naked Seeded - Trick or Treat

Ornamental - Sweetie Pie

Muskmelon: Flyer, Early Dawn

Watermelon: Stokes Sugar, Yellow Baby (yellow flesh), Canada Super Sweet

Seed treatment

Purchase treated seed or treat seed with Thiram or Captan according to manufacturer's directions.

Seeding, planting and spacing

The vine crops are warm-season crops and soil temperatures must be 16°C or higher before germination occurs. They have no frost tolerance and must be planted after all danger of frost has past.

Pickling cucumbers will mature from seed in most areas of Alberta. However, their production can be less risky, earlier and higher yielding, especially in central and northern regions, if they are grown with the aid of transplants, mulch, tunnels, hotcaps or some combination of these. Refer to Section 1 of this guide for details on the use of hotcaps and plastic tunnels.

In southern regions slicing cucumbers, squash and pumpkin will mature well from seed. In central and northern areas of the province, these crops will require transplanting and some form of plant protection such as plastic mulch, tunnels or hotcaps.

Muskmelon and watermelon should be started in 7 cm (3 in.) peat pots about 3 weeks before field setting. Mulch, hotcaps and tunnels will improve yield and earliness, consequently direct seeded crops will mature if in southern Alberta.

Approximate seed requirements per acre are:

	Transplants	Direct Seeded
Pickling cucumbers	1-2 lb	4-5 lb
Slicing cucumbers	1-2 lb	3-4 lb
Pumpkin & squash (large seed)	2 lb	3-4 lb
Pumpkin & squash (small seed)	1-2 lb	1-3 lb
Muskmelon	1-2 lb	-
Watermelon	1 lb	-

Seed sizes vary greatly and seed counts per kg (per lb) will help in determining amounts required.

Plant cucumbers 1-2 cm (0.5-1 in.) deep. Squash and pumpkins are planted 2-5 cm (1-2 in.) deep.

The following are approximate final spacings for vine crops:

	Between Rows	Within Rows
Pickling cucumbers	4-6 ft	3-6 in.
Slicing cucumbers	4-6 ft	12 in.
Summer squash (bush types)	4-5 ft	18-24 in.
Bush pumpkin	3-4 ft	3 ft
Vining pumpkin & squash	6-8 ft	2-3 ft
Muskmelon	6 ft	2 ft
Watermelon	6 ft	2 ft

Fertilizer

Growers should always base fertilizer application rates on the results of annual soil tests.

Before planting, broadcast and work in 45 kg/ac of 34-0-0 and 100 kg/ac of 11-55-0 or the equivalent.

Sidedress with 35 to 40 kg/ac (85 to 100 kg/ha) of 34-0-0 when plants start to run. This later application can be applied through the irrigation system.

Weed control

Cucumbers only - Alanap-3 (240 g/L naptalam). Apply Alanap-3 at 4.4 to 12.1 L/ac (11.0 to 30.0 L/ha) as a preemergence treatment after planting. Do not apply during very wet and cold weather as stunting of the crop may occur. Where clear plastic mulch is used, the herbicide should be applied before the mulch is laid and prior to seeding. Alanap-3 controls lamb's-quarters, pigweed, purslane and green foxtail. Tests at the Research Center in Brooks have shown that Alanap-3 causes unacceptable injury to pumpkin and squash seedlings. Although Alanap-3 is registered for pumpkins, squash and melons, its use in Alberta is not recommended. This product generally provides 3 to 6 weeks of weed control. When irrigation is used, best results are obtained when water is applied before the application of Alanap. Alanap-3 can be activated after application to a dry soil by limited irrigation.

Alanap-3 is not widely used in Alberta, consequently growers may encounter difficulty in locating a supplier. Alanap is a product of Uniroyal Ltd.

Pumpkin and Squash only - Amiben DS (chloramben 75%) is registered for use on pumpkin and squash as a preemergent treatment aftering planting. Apply Amiben DS at 1.2 kg/ac in 40 to 60 L/ac water. Amiben DS is a product of Union Carbide Agricultural Products (Canada) Ltd.

Cucumbers Only - Prefar (bensulide 480 g/L) controls barnyard grass and green and yellow foxtail. Prefar at 4.8 to 5.7 L/ac should be tank mixed with Alanap-3, 3.8 to 7.7 L/ac in 40 to 160 L/ac water. Incorporate lightly 2.5 to 3.5 cm into the soil just prior to planting. When tank mixed with Alanap-3, incorporation should be 2.5 cm or less.

Use the lower rate on sandy soils. Do not apply Prefar more than once every 12 months. To avoid crop injury, rotate only to cucumbers, peppers, cole crops, carrots, lettuce, tomatoes, pumpkin or squash. Prefar 4.8 E is a product of Chipman Inc.

- Poast EC (184 g/L sethoxydin). See table 7, pages 36-37 for control of grasses and rates to be used. Tilt spray boom forward 45° for better coverage. Treat when grasses are actively growing and at recommended leaf stage. Do not allow spray mixture to sit overnight. Addition of ammonium sulphate enhances control. Allow a period of at least 30 days from application to harvest. Maximum allowable rate is 1.78 L/ac.

Insect control

Cutworms on cucumbers

Usually red-backed cutworm, which cuts off plants at or below ground level in spring.

Apply one of the following materials:

Preseeding

Lorsban 4E, 48 EC at 970 ml/ac (60 days). Apply once 3-7 days before planting or transplanting. Do not incorporate.

Post-seeding or transplanting

Lorsban 4E, 48 EC at 480 to 970 ml in 80 to 160 L water/ac (60 days). Apply once at 2 to 5 leaf stage.

Alternative chemicals and formulations: Lorsban 25 WP (60 days).

Disease control

Angular leaf spot

Use disease-free seed grown in a dry area if possible. Turn under crop refuse promptly after harvest. Follow a 3-year crop rotation. Do not work in the crop when foliage is wet. The pickling variety Pioneer is resistant to angular leaf spot. At first sign of disease, apply Kocide 101 50 WP at 0.9 to 1.3 kg/ac (1 day), C.O.C.S. 50 WP at 1.3 to 1.8 kg/ac (1 day) or Chem Cop 53 WP 1.1 to 1.3 kg/ac (1 day) and repeat at weekly intervals or as required.

Damping-off

Use steamed or fumigated soil or synthetic mix for starting plants. Avoid seeding in cold, wet soil. Treat with Captan or Thiram seed protectants.

Wilt

Use disease-free seed. Start plants in steamed or fumigated soil. Avoid fields known to be infested with wilt fungi. Check seed catalogues for wilt resistant varieties.

Special problems

Pollination

All vine crops depend on insects to transfer pollen from the male to female blossoms. In small plantings, there may be enough native insects to perform the service. In large plantings, growers should provide one colony of honey bees for every 0.5-1.5 ha (2-3 ac) to ensure adequate pollination.

Storage and handling

Cucumbers and summer squash should be stored at 7-9°C and more than 95% relative humidity. A storage life of 10-14 days can be expected. Cucumbers and summer squash are sensitive to chilling injury at temperatures below 7°C. Avoiding moisture loss is important.

Muskmelons store best at 0-7°C and 90% relative humidity. Muskmelons normally have a storage life of approximately 2 weeks at 0°C. Some varieties may, however, suffer from low temperature breakdown at 0-7°C. Only mature melons should be stored.

Pumpkins and winter squash store best at 7-10°C and 70-75% relative humidity. Pumpkin and winter squash should be cured for 2 weeks at 25-30°C to aid the healing of minor injuries. After curing, temperatures should be reduced to the 7-10°C range. Storage life of pumpkin and squash depend largely on their type and variety.

Grade and packaging standards

The following is a guide and has no official sanction.

There are no grades for fresh pickling cucumbers, squash, pumpkins and melons, however, growers should only offer fresh quality produce free from decay, insects, injury and other defects.

The grades for field cucumbers are Canada No. 1 and Canada No. 2. Generally Canada No. 1 field grown slicing cucumbers are fresh, sound and firm; are straight, and not constricted, tapered or pointed, and are green in color over 85% of the area; are free from damage, decay and sunscald; do not vary more than 2 cm (0.75 in.) in diameter and 5 cm (2 in.) in length when in a package; have a minimum diameter of 6 cm (2.75 in.) and minimum length of 15 cm (6 in.).

Canada No. 2 cucumbers are similar to Canada No. 1, but require green color on only 75% of surface area and have a minimum length of 10 cm (4 in.). Diameter restrictions do not apply.

A set of general tolerances apply to these grades.

There are no official package sizes for field cucumbers.

LETTUCE

Varieties

Crisphead or Iceberg types: Jasmin, Merit, Great Lakes 118 and 659-700

Butterhead types: Buttercrunch, Kagran Summer, Nancy

Cos lettuce: Parris White

Leaf lettuce: Grand Rapids, Salad Bowl, Ruby, Red Sails

Seed treatment

Purchase treated seed or treat with Captan or Thiram seed treatments following manufacturer's directions.

Seeding, planting and spacing

Lettuce seed will germinate at soil temperatures over 4°C and can be planted early.

Lettuce is direct seeded or transplanted.

Direct seeded using a drill type seeder requires 0.5 to 1.0 kg/ac seed. Lettuce seed can be pelleted for use with a belt-type precision seeder. The amount of pellets required will depend on pellet size, seed germination and spacing required. Plant lettuce seed 1 cm (0.5 in.) deep.

Lettuce does well if seeded in the fall or very early spring months. Frost tolerance is high. Well hardened lettuce transplants will withstand spring frosts and can be field set relatively early (April 25-May 15). Transplants should be seeded about 4 weeks prior to field setting. Either direct seeded or transplanted crops that mature during hot weather may deteriorate rapidly in the field. Leaves brown and heads may sunscald in extreme heat.

The final spacing should be from 30-60 cm (12-24 in.) between rows and 30 cm (12 in.) apart in row.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Before planting, broadcast and work in 100 kg/ac of 11-55-0 and 100 kg/ac of 34-0-0 or the equivalent.

Weed control

CIPC (chloropropham 480 g/L) at 3.8 L/ac in 60 to 120 L/ac of water. CIPC is registered to control some annual broadleaved weeds and some annual grasses. Apply after seeding but before crop emergence. May cause crop injury and delayed maturity in cool, wet weather. Overhead irrigation is required after application.

Insect control

Aphid

Green, yellow or pink species. They feed on inner leaves. If problems have been experienced in previous years, follow continuous program during growing season. Keep plantings away from greenhouses and urban areas.

Apply one of the following as a foliar spray and alternate between chemical groups:

Monitor 48 SN at 445 to 930 ml/ac (14 days). Apply at 7-10 day intervals.

Phosdrin 60 SN at 180 ml/ac (3 days), or

Pirimor 50 WP at 120 to 200 g/ac in 200 to 400 L water (7 days). Repeat if necessary.

Alternative chemicals and formulations: Cygon (System) 48 EC (7 days); Lagon 480 E (7 days); Systox 24 EC, 72 EC (21 days); Thiodan 50 WP, 40 EC (14 days); Malathion 25 WP, 85 EC, 4 DU (3-14 days); Dibrom 86.4 EC, 65.4 EC (4 days).

Cutworm

Apply the following material:

Ambush 50 EC at 60 ml/ac (1 day). Where cutworms are large or soil conditions are dry use 90 to 120 ml/ac. Do not disturb soil surface for 5 days after treatment.

Leafhopper

They are small, pale-yellow, flying insects that are only of significance if they transmit aster yellows mycoplasma. Plant away from cereal crops where leafhoppers breed. Rogue out infected plants.

Apply one of the following materials as foliar sprays if necessary:

Phosdrin 60 SN at 180 ml/ac (3 days), or

Malathion 25 WP at 1.1 to 2.2 kg/ac (3-14 days), or

Thimet 10 G at 4.5 kg/ac. At planting time only. Do not place in direct contact with seed.

Alternative chemicals and formulations: Malathion 85 EC, 4 DU (3-4 days); Thimet 15 G (P), Sevin 43 SU, 50 WP, 85 WP (14 days); Methoxychlor 50 WP (14 days).

Disease control

Fungal rots

Turn under crop refuse promptly after harvest. Avoid poorly drained fields and overcrowded planting. Discard heads with any trace of infection at harvest. Avoid sprinkling crops during mid day and at crop maturity. Pre-cool promptly after harvest.

Storage and handling

Lettuce stores best at 0°C and relative humidity greater than 95%.

Head lettuce can be stored satisfactorily for up to 3 weeks if field heat is rapidly removed and a 0°C temperature is maintained.

Preventing moisture loss by the use of plastic bags should also be considered.

Grade and packaging standards

The following is a guide and has no legal sanction.

The grades for head lettuce are Canada No. 1 and Canada No. 2. Generally, Canada No. 1 head lettuce has similar varietal characteristics; has wrapper leaves that are not wilted; has compact heads; in the case of crisphead types has no more than 8 wrapper leaves; is free from split heads; is free from decay or tipburn; is free from injury; when packaged has heads that do not vary more than 5 cm (2 in.) in diameter.

Canada No. 2 lettuce has more tolerance to injury and defect and no limitation on size variation in a pack.

A series of general tolerances exist for these grades.

There are no standard packages for lettuce although it is usually packed by count in cartons.

ONIONS

Varieties

Yellow Globe cooking onions: Norstar, Improved Autumn Spice,

Spanish types (fall seeded or transplants only): Cima, White Sweet Spanish, Sweet Sandwich

Bunching onions: Hardy White Bunching, Japanese Bunching, White Lisbon, White Spanish Bunching

Pickling onions: White Barletta, White Pearl

Seed treatment

Purchase treated seed or treat seed with Captan or Thiram seed treatments following manufacturer's directions.

Seeding, planting and spacing

Onions will germinate at cool temperatures and can be planted when soil temperature reaches 5°C. Seeds are planted 1-2 cm (0.5-.75 in.) deep.

Dry bulb onions from seed: Dry bulb onions require a long (120 + days) season to mature and should be planted early in spring or in the fall. In the spring,they should be planted as early as April 10, or in the fall, end of October if possible. Yields are significantly reduced if seeded after about May 1.

Dry bulb onions are best seeded with a belt type precision seeder. Seeds are planted about 5 cm (2 in.) apart in a double line using a double row shoe and belts punched with two rows of holes. Number of holes and hole size varies as planting requirements and seed size vary. About 2-3 lb of seed are required per acre.

Rows for dry bulb onions have traditionally been 45-60 cm (18-24 in.) apart depending on equipment available. Recent trends are for onion rows to be planted as close as 25-30 cm (10-12 in.) apart in beds containing 5-6 rows. Complete chemical weed control is necessary if the narrow row spacing is used. The close spacing tends to increase yields and promote earlier maturity. Bulb size can be reduced at close spacings.

Transplanting Onions: Standard dry bulb varieties in northern areas and Spanish type onions in all areas of the province need to be planted as transplants if they are to mature. Seeds should be started in flats about 6-8 weeks prior to planting. Seedlings should be field set from about May 1 to 15. Space plants 10-15 cm (4-6 in.) apart in rows that are 45-60 cm (18-24 in.) apart.

Bunching and Pickling Onions: These onions should be planted as early as possible in the spring. High populations of evenly spaced plants result in good yields of uniform onions. A belt-type precision seeder is best for seeding bunching and pickling onions. Seed reqirements range from 20 to 30 kg/ac but may vary depending on seed size and row spacing used.

More detailed information on production of onions is available in a factsheet titled *Commercial Onion Production in Alberta*, FS 258/20-5.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Before planting, broadcast and work in 35 kg/ac of 11-55-0 or the equivalent.

For direct seeded dry bulb onions, the preplanting application of 11-55-0 can be reduced and some of the 11-55-0 can be banded to the side and below the seed at the time of planting.

Dry bulb onions may require an additional side dress application of nitrogen in July. Apply 10 to 15 kg/ac of nitrogen either as a side dress application or about 35 kg/ac of 34-0-0 applied through the irrigation system.

Weed control

Herbicide Trade Name (generic name)	Product Rate (per acre)	Remarks
Goal EC (192 g/L oxyfluorfen)	253 ml	Apply when onions have two fully developed true leaves and weeds are small. Growers should consider the use of Gramoxone prior to crop emergence to kill weeds. Repeat applications required whenever a new flush of weeds appear. Do not apply in excess of 1 L/ac or within 56 days of harvest. Goal is available through Pfizer dealers.
Hoe Grass 284 (284 g/L diclofop methyl)	1.4 L Add assist oil concentrate according to label directions.	Refer to table 7, pages 36-37 for weeds controlled. Apply in 45 L/ac water at 275 kPa with spray at 45° angle forward. Weeds should not be under stress.
Poast EC (184 g/L sethoxydim)	Maximum 1.78 L Add assist oil according to label directions.	Refer to table 7, pages 36-37 for rates and control of specific grasses. Treat when grasses are actively growing and at recommended leaf stage. Allow 4 days between application of Poast and any other chemical. Tilt spray boom forward 45° for better coverage. Do not allow spray mixture to sit overnight. Addition of ammonium sulphate enhances control. Interval from application to harvest is 60 days. Poast is registered for use in garlic.
Excel (90 g/L fenoxaprop-ethyl)	1 L	Refer to table 7, pages 36-37 for grasses controlled. Application to harvest must be at least 60 days. Water volume of 50 L/ac and spray pressure of 275 kPa is required. Apply spray at 45° angle forward for better spray coverage. Weeds should be actively growing.

Herbicide Trade Name (generic name)	Product Rate (per acre)	Remarks
Fusilade (250 g/L fluazifop-butyl)	Maximum 0.4 L	Refer to table 7, pages 36-37 for rates and control of specific grasses. Apply three days before application of any broadleaf herbicides. Add Agral 90 surfactant according to label directions. Minimum interval to harvest is 42 days. Women capable of bearing children should be particularly careful when handling this product.

Insect control

Onion maggot

It is a small, greyish fly that lays eggs at the base of the plant. Small white maggots feed in the onion bulb and may introduce rots.

A. Onions Grown From Seed

Use seed + foliage, furrow + foliage, or foliage treatments alone. All onion seed must be treated with a sticker to hold the insecticide on the seed. If a fungicide is also being applied it should be applied before the insecticide.

Seed Treatment

1. Preparation of the sticker:

Add Methocel (grade 25 Methyl cellulose) at 50 g/L (8.0 oz/gal) of hot water and let stand overnight at room temperature.

Add 60 ml (1 fl oz) of the Methocel solution per kg (lb) of seed. Mix until all the seeds are coated and shiny black.

2. Addition of insecticide:

Add Diazinon 50 WP at 125 to 200 g/kg (1.0 to 3.5 oz/lb)of seed. Mix well. Do not store treated seed for longer than 3 weeks, or

**Ethion 25 WP at 1 kg/4 kg (1 lb/4 lb) of seed.

Furrow Drench Treatment

Diazinon 50 EC at 0.9 to 1.8 L/ac or 70 to 100 ml/500 m of row at 40 cm row spacing (2.0 to 3.0 fl oz/500 yds of row at 15 in. row spacing) at seeding or planting time.

Furrow Granular Treatment

Growers equipped with multiple row seeders or transplanters and granular chemical applicators should use this treatment. Place one of the insecticides listed in the chart in the furrow with the seed or transplant at planting time:

Alternative chemicals and formulations: Furadan 10G (dry bulb only), Trithion 10G, Lorsban 15G*.

** Not on label and apparently not a registered use. Included in B.C. recommendations.

	Rate g/100 m (oz/1000 ft)	kg/ac for Row Width in. (cm)			
Insecticide	of Row	12 (30)	14 (35)	16 (40)	24 (60)
Diazinon 5G	85 (9.0)	11.3	10	9	5.7
or,					
Dyfonate 10G*	57 (6.0)	7.7	7	6	3.6
or,					
Ethion 5G	134 (15.0)	10.5	12	14	21
or,					
Dasanit 15 G* (Dry bulb only)	30 (3.0)	2.4	2.6	3	4.5

Foliage Treatment

Because of erratic results, which may occur with furrow treatment, emphasis must also be placed on spraying foliage to kill onion maggot flies. In Alberta, the exact emergence time of maggot flies is not known. In British Columbia, three foliage sprays are applied at 10 day intervals as soon as the first dandelions start to flower.

An additional three sprays are applied at 10 day intervals beginning the third week of June. One or two further sprays may be necessary starting the first week of August if the crop is not lifted before September. The headlands around the fields should also be sprayed each time. Apply one of the following materials:

Diazinon 50 EC at 445 ml/ac for adult flies, or
Dibrom 86.4 EC at 220 ml/ac for adult flies.

B. Onions Grown From Sets, Multipliers or Transplants

Use the furrow + foliage treatments or the foliage treatments alone, as given earlier.

*NOTE: Do not use Dyfonate 10G on pickling and green bunching onions or on onions grown from sets or on soils with less than 10% organic matter.

Do not use Lorsban 15G or Dasanit 15G on green bunching onions or on onions grown from sets.

Onion Thrips

These are tiny black or yellow insects causing silvering of leaves and damage to bulbs in storage.

Apply one of the following materials and repeat 3 times at 10 day intervals:

Diazinon 50 EC (or 50 WP) at 445 ml/ac (10 days), or
Dibrom 86.4 EC at 220 ml/ac (4 days), or
Malathion 25WP at 1.70 kg/ac (3 days).

Alternative chemicals and formulations: Malathion 4 DU (3 days); Methoxychlor 50 WP, 24 EC (7 days); Rotenone 5 WP, 5 DU (1 day).

Disease control

Basal rot

Avoid planting sets and transplants in new land that is to be used for onion production because the disease may be introduced in this way. Follow a 4 year rotation. Control onion maggots. Avoid injury to bulbs during cultivation, harvesting and storage. Keep storage temperatures below 4°C.

Neck rot (Botrytis leaf blast)

Grow resistant early maturing, tightnecked varieties. Seed as early as possible and at recommended rates. Apply Zineb, Mancozeb, Dithane, Dyrene, Difolotan or Rovral to control Botrytis leaf blast every 7 to 14 days at label rates if symptoms appear. Restrict soil moisture and nitrogen early in August to initiate curing. Do not lift onions until two-thirds of the tops are down. Undercutting will accelerate this process. Do not top poorly cured bulbs. Apply fungicide just prior to lifting when curing is unsatisfactory or levels of blast are high. Heat cure onions in storage (see storage and handling recommendations) then remove tops before packing.

Sprout inhibition

Maleic hydrazide is sold under many trade names such as Royal MH 60SG, Gro-Tard, MH 30, Retard, Slo-Gro, Sprout-Stop and Malazide. Maleic hydrazide should be applied when bulbs are fully mature, have at least 5-8 green leaves and neck is soft enough for the tops to fall if they have not already done so. The spray is applied when 50% of the tops have fallen but are still green. This usually occurs 10 to 14 days before harvest. Sprout inhibitors should be applied only to good keeping varieties because it will not improve storage life of poor keeping varieties.

Storage and handling

Dry bulb onions store best at 0-1°C and 70-75% relative humidty.

Bulb onions should be sprout inhibited with maleic hydrazide when tops start to go down. Lifting should occur after 50% of tops are down.

Bulb onions should be cured after harvest by raising temperatures to 32-34°C with adequate ventilation for a period of 10-14 days. Moisture loss during curing will be about 5% by weight. Initially, ventilation rates should be 9.15 m^3/minute per square metre of floor space. After 10 to 14 days this is reduced to 4.57 m^3/minute per square metre.

After curing the temperature should be reduced to 0-1°C and ventilation rates reduced. Temperatures should not be lowered more than 2°C per day to avoid condensation on bulb surfaces.

Failure to properly cure onions can result in serious storage losses as a result of neck rot.

Green bunching onions are best stored at 0-1°C and 95% relative humidity.

Grade and packaging standards

The following is a guide and has no official sanction.

The grades for onions are Canada No. 1, Canada No. 1 pickling and Canada No. 2.

Canada No. 1 onions: have similar varietal characteristics; are well cured; are firm; are free from thick necks, seed stems, sprouts and decay; are free from damage; have a minimum diameter of 4.5 cm (1.75 in.) and a maximum diameter of 7.5 cm (3 in.). The designation of 'small' may be used for Canada No. 1 onions that have a minimum diamter of 3.2 cm (1.25 in.) and a maximum diameter of 4.5 cm (1.75 in.). The designation 'jumbo' may be used for onions with a minimum diameter of 7.5 cm (3 in.). The designation "medium" can be used for onions with a minimum diameter of 5.7 cm (2.25 in.) or greater.

In any year, onions produced and marketed before September 16 may be of lesser maturity and be less firm than onions marketed after that date and still meet the requirements of Canada No. 1 grade.

Canada No. 1 pickling onions: are similar in varietal characteristics; are cured; are firm; are free from thick necks, seed stems, decay and damage; have a minimum diameter of 13 mm (0.5 in.) and maximum diameter of 25 mm (1 in.), or a maximum diameter of 38 mm (1.5 in.), providing the package is so marked.

Canada No. 2 grade onions are similar to Canada No. 1 grade, except that they may be less mature and no maximum size designations are indicated.

The following general tolerances apply to Canada No. 1 and Canada No. 2 onions: 5% by weight may be below the prescribed or designated size; 5% by weight may exceed the maximum size, additionally 15% of the onions by weight may exceed the maximum size during July and August in any year when grown from sets and marked as 'small'; 2% by weight may be affected by decay; 5% by weight may have grade defects as related to size but including decay and still meet the grade standards. Similar tolerances are in effect for Canada No. 1 pickling onions.

Package sizes for onions are 1.36 kg (3 lb), 2.27 kg (5 lb), 4.54 kg (10 lb), 11.3 kg (25 lb) bags and 22.7 kg (50 lb) bags or cartons.

PARSNIPS

Varieties

Harris Model, Hollow Crown

Seeding and spacing

Seed as early as possible in the spring at a rate of about 1.3-2.2 kg/ac. Seed 1-2 cm (0.5-.75 in.) deep. Seeds should be seeded in a double line band 7 cm (3 in.) wide. Final stands should be 20-30/m (6-10/ft). Rows are spaced 45-60 cm (18-24 in.) apart. Parsnips are a very long season crop and the rate of germination is slow. Therefore, it is essential to sow early to obtain a good yield of high quality parsnips.

Soil

Parsnips, like carrots, require deep well drained soils. Soil preparation must include deep plowing to a minimum of 30 cm (12 in.). Well drained loamy sands and sandy loams are ideal for parsnip production.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Before planting, broadcast and work in up to 90 to 100 kg/ac of 11-55-0 and 90 kg/ac of 34-0-0 or the equivalent.

Broadcast about 15 kg/ac of nitrogen as 40 kg/ac of 34-0-0 or put about 15 kg/ac of nitrogen through the irrigation system during the growing season.

The phosphorus fertilizer may be banded into the seedbed prior to planting.

Weed control

Afolan F (linuron 450 g/L). Apply Afolan F at 0.8 to 2.0 L/ac when parsnips have two or more fully developed leaves. Apply before annual grasses exceed 5 cm in height. During hot, dry weather, spray in the cool part of the day to avoid injury.

Herbicidal Oil. Apply 240 to 325 L/ac as an overall treatment when the crop is in the two to four leaf stage and weeds are less than 10 cm (4 in.) tall.

For further details, refer to the weed control section on carrots, page 69.

Disease control

Sclerotinia rot (cottony soft rot)

Rotate with resistant crops such as grasses, cereals, beets, onions, spinach or corn. Plant in well-drained soil. Use a plant spacing that allows for good air circulation among plants. Practise good field sanitation by removing and destroying diseased plants. (See Cole crops - sclerotinia rot)

Storage and handling

Parsnips store best at 0°C and 95% relative humidity or more. Parsnip handling should be similar to that of carrots.

Grade and packaging standards

The following is a guide and has no legal sanction.

The grades for parsnips are Canada No. 1, Canada No. 1 cut-crowns and Canada No. 2. Generally, Canada No. 1 parsnips have similar varietal characteristics; are firm; are not trimmed into the crown but have tops trimmed no longer than 1 cm (0.5 in.); are smooth and clean; are free from cracks, damage and decay; have a minimum diameter of 2 cm (1 in.) and a maximum diameter of 7.5 cm (3 in.) with a minimum length of 12.5 cm (5 in.). Federal regulations now permit parsnips to be packaged with a minimum diameter of 4.5 cm (1.75 in.), however they must be marked as 4.5 cm (1.75 in.) and up. When packed as prepackaged products, parsnips must not vary more than 3 cm (1.5 in.) in diameter.

A series of general tolerances apply to these grades.

Standard package sizes for parsnips are 454 g (1 lb), 907 g (2 lb), 11.3 kg (25 lb) and 22.7 kg (50 lb) bags.

PEAS

Varieties

Fresh market: Early - Orea, Olympia, Vulcan, Banquet

Late - Novella, Green Arrow, Trifect, Bolero, Stampede, Dual, Rampart, Headliner

Process market: As required by processors

Snow Peas: Giant Dwarf Sugar, Oregon Sugar Pod, Dwarf Grey Sugar

Dry peas: Trapper, Century, Tara, Triumph, Lenca, or as required by contracting company.

Seed treatment

Purchase treated seed or treat seed with Captan following manufacturer's directions.

Seed should be treated with bacteria inoculant in the drill box at seeding time to promote the development of root nodules, which are required to 'fix' nitrogen from the air.

Seeding and planting

Plant peas when soil temperatures reach 4°C or when directed by the contracting company. Normal seeding dates range from April 25 to May 10 but are delayed in the case of late processing crops.

Peas should be planted into soil moisture at about 5 cm (2 in.) deep.

Seeding rates vary considerably depending on variety, seed size, availability of irrigation and whether the peas are used for fresh market, processing or seed. Normal ranges are from 80 to 140 kg/ac. If peas are row-cropped 20 to 45 kg/ac is required.

Peas grown for market gardening may be planted as a row crop at 60 cm (24 in.) between rows; planted in beds of rows 15-25 cm (6-10 in.) apart leaving a walkway between beds every 120-180 cm (4-6 ft); or they may be planted in solid plantings using a grain drill which spaces rows 15-25 cm (6-10 in.) apart. Peas grown for processing or seed are planted with a standard grain drill which spaces rows 15-25 cm (6-10 in.) apart. In all cases seeds are planted about 2-5 cm (1-2 in.) apart in the row.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Before planting, broadcast and work in 50 kg/ac of 34-0-0 and 35 kg/ac of 11-55-0 during soil preparation. Drill an additional 35 kg/ac of 11-55-0 at seeding time.

Weed control

Treflan (trifluralin 545 g/L), Rival 500. Apply

either as a spring or fall preplant incorporated treatment. Application instructions are the same as for beans.

Basagran (bentazon) 480 g/L. Apply after peas have three pairs of leaves. Other application instructions are the same as for beans.

Hoe Grass 284 (diclofop methyl 284 g/L). Controls wild oats, green and yellow foxtail and barnyard grass. Apply 1.0 to 1.1 L/ac in at least 40 L/ac water with nozzles directed forward 45 degrees. Apply when weeds are at the one to four leaf stage. Other herbicides for broadleaf control must be applied at least four days after Hoe Grass 284 application. Do not apply if rain is expected within one hour. Refer to table 7, pages 36-37 for other details. Please note: 60 days pre-harvest interval is required.

MCPA Sodium Salt 300 g/L. Controls several broadleaf weeds. Refer to table 7, pages 36-37 for details. Apply .365 to 605 ml/ac in not less than 60 L/ac of water when pea vines are 10-18 cm (4-7 in.) long. MCPA sodium salt may be mixed with Dalapon or TCA.

MCPA Amine (500 g/L). Apply 110 to 280 ml/ac in not less than 70 L/ac of water when pea vines are 10 to 18 cm (4 to 7.5 in.) long.

Tropotox Plus (375 g/L MCPB + 25 g/L MCPA). Controls several broadleaf weeds; refer to table 7, pages 36-37 for details. Apply 1.1 to 1.7 L/ac, depending on weeds to be controlled when peas have three to six expanded leaves. Apply chemical in 60 to 80 L/ac of water. Spray when the crop and weeds are actively growing and weeds are at a susceptible stage.

Edge DF (50% ethalfluralin). Apply 0.65 to 0.89 kg in spring or 0.89 to 1.13 kg in fall. Proper agitation in spray tank and careful adherence to mixing instructions are very important. Incorporate (within 24 hours of application) with Tandem disc, discer or vibrashank cultivator as per label instructions. Do not use when field is crusted, lumpy or too wet for good incorporation.

Insect control

Aphid

Large green species clustered on growing tips, leading to stunting. They may be controlled by ladybeetles and other predators. If necessary apply one of the following materials:

Pirimor 50 WP at 60 to 110 g/ac in 6.9 L of water (6 days). Apply by aircraft.

Phosdrin 60 SN at 180 ml/ac (1 day).

Cygon 4E, 48 EC at 110 to 170 mL/ac (3 days).

Alternative chemicals and formulations: Lagon 480E (7 days); Thiodan 50 WP, 40 EC (7 days); Malathion 4 DU, 25 WP, 50 EC, 85 EC (3 days); Lannate 21.5 SN (1 day); Systox 24 EC, 72 EC, (21 days); Di-Syston 72 EC (50 days); Dibrom 86.4 EC, 65.4 EC (4 days); Rotenone 1 DU (1 day).

Spider mite

Tiny sucking arthropods on leaves. Their feeding causes loss of color and vigor. Plant away from greenhouses and urban areas.

Apply one of the following if necessary:

Phosdrin 60 SN at 180 ml/ac (1 day), or

Dibrom 86.4 EC at 445 to 890 ml/ac (4 days), or

Malathion 50 EC at 810 ml/ac (3 days).

Alternative chemicals and formulations: Malathion 4 DU, 25 WP, 85 EC (3 days); Dibrom 65.4 EC (4 days); Di-Syston 72 EC (50 days).

Thrips

Tiny, slim, usually black or brown insects, which rasp flowers and leaves leaving silvery blotches.

Apply one of the following materials:

Di-Syston 72 EC at 60 to 140 ml/ac (50 days). Do not apply more than once per season or,

Rotenone 1 DU at 14 to 18 kg/ac (1 day).

Disease control

Powdery mildew

Destroy or plow under diseased crop debris. Rotate to allow 4 years between pea crops. Seed early to avoid infection. If chemical control is required, apply sulphur 92 WP at 2.7 to 3.6 kg/ac (1 day) as soon as symptoms appear and at 7-14 day intervals until harvest.

Root rot

Peas should not be planted on the same land more frequently than every fourth year. Plant in well-drained soil. Do not pack soil. Avoid over-irrigation. Plow under diseased crop debris. Do not crowd plants. Drill in high analysis phosphate fertilizer with the seed. If weather is cold and wet at planting, disc in 30 kg/ac of 34-0-0 fertilizer. Refer to seed catalogues for information on resistant varieties.

Seed rot and damping-off

Avoid planting in cold, wet soil. Avoid excessive irrigation. Improve the texture of heavy soil, if practical. Treat seed with Captan or Thiram before planting.

Storage and handling

Fresh peas store best at O°C and relative humidity greater than 95%. If peas are to be stored at all they should be stored in the pod. A storage life of 4-7 days can be expected.Peas should be cooled as rapidly as possible to remove field heat.

Grade and packaging standards

There are no federal grade standards for fresh market peas.

Generally, process peas are paid for on the basis of maturity. Prices for peas are based on 'tenderometer' readings and are outlined in company contracts.

Dry peas grown for seed are graded by the contracting company. Growers should be aware of the requirements of the contracting company to ensure their crop management provides for the highest yield of No. 1 seed and that weed seeds and shrivelled seeds are kept to a minimum.

POTATOES

Potato production requires a high degree of management skill and technical knowledge. The following is only an outline of potato production recommendations. Growers are urged to obtain more detailed information from the Alberta Agriculture factsheets on potatoes listed at the back of this guide or to contact the potato production specialist also listed on the back of this guide. Detailed information on commercial production of potatoes is available from the publication titled "Potato Production Guide", Agdex 258/20-8.

Varieties

Russet Burbank

Primary Use: French fry
Secondary Use: Fresh market. Good baking and boiling.
Maturity: Late (120 days)
Tuber: Shape - Long, slightly flattened
Eyes - Numerous; acceptable
Skin Color - Tan
Skin Texture - Russeted, netted
Flesh Color - White
Flesh Texture - Dry, mealy
Flower Color: White
Specific Gravity: High
Resistances: Moderately resistant to scab, blackleg
Susceptibilities: Subject to second growth, knobbiness, hollow heart in Alberta. Susceptible to leaf roll, Verticillium wilt, virus X and Y.
Storability/Dormancy: Stores well, long dormancy.

Norchip

Primary Use: Chipping
Maturity: Mid-season
Tuber: Shape - Round to oval
Eyes - Shallow
Skin Color - Creamy white
Skin Texture - Smooth
Flesh Color - White
Flesh Texture - Dry, mealy
Flower Color: White
Specific Gravity: High
Resistances: Moderately resistant to scab, Verticillium wilt, virus Y.
Susceptibilities: Black leg, leaf roll, virus X, growth cracks.
Storability/Dormancy: Stores well, requires sprout inhibition for long-term storage.

Norgold Russet

Primary Use: Fresh market only. Good boiling and baking.
Maturity: Early mid-season
Tuber: Shape - Oval-oblong
Eyes - Shallow
Skin Color - Tan
Skin Texture - Russeted, netted
Flesh Color - White
Flesh Texture - Dry, mealy
Flower Color: Pink
Specific Gravity: Medium to high
Resistances: High resistance to scab.
Storability/Dormancy: Stores well. Medium dormany.

Norland

Primary Use: Fresh market only. Good boiling, fair baking.
Maturity: Early
Tuber: Shape - Round to oval
Eyes - Shallow
Skin Color - Red
Skin Texture - Smooth
Flesh Color - White
Flesh Texture - Somewhat wet
Flower Color: Purple
Specific Gravity: Medium
Resistances: Moderately resistant to scab, leaf roll,

Verticillium wilt, viruses X and Y.
Susceptibilities: Highly susceptible to silver scurf.
Storability/Dormancy: Short dormancy. Red color tends to fade by the New Year.

Superior

Primary Use: Chipping
Secondary Use: Early fresh market
Maturity: Early mid-season
Tuber: Shape - Oval
Eyes - Medium in depth
Skin Color - Creamy white
Skin Texture - Smooth
Flesh Color - White
Flesh Texture - Dry, mealy
Flower Color: Pale Lilac
Specific Gravity: Medium
Resistances: Moderately resistant to common scab.
Susceptibilities: Susceptible to Verticillium wilt and potato virus.
Storability/Dormancy: Not a storage potato.

Shepody

Primary Use: French Fry
Secondary Use: Fresh market
Maturity: Mid-season
Tuber: Shape - Oblong to long
Eyes - Shallow
Skin Color - Buff
Skin Texture - Smooth to light net
Flesh Color - White
Flesh Texture - Dry, mealy
Flower Color: Light violet
Specific Gravity: High
Resistances: Moderately resistance to Rhizoctonia
Susceptibilities: Susceptible to potato viruses S, X and Y, leaf roll. Moderately susceptible to common scab.
Storability/Dormancy: Currently not stored for processing.

Sangre

Primary Use: Fresh Market
Maturity: Mid-season
Tuber: Shape - Oval
Eyes - Shallow
Skin Color - Red
Skin Texture - Slightly rough
Flesh Color - White
Flesh Texture - Somewhat dry and mealy
Flower Color: Lavender
Specific Gravity: Medium
Resistances: Moderately resistant to leaf roll, net necrosis, and rarely exhibits hollow heart, internal discoloration and blackspot.
Susceptibilities: Susceptible to Verticillium, early and late blight.
Storability/Dormancy: Holds bright red color well past Norland.

Carlton

Primary Use: Fresh Market
Maturity: Early
Tuber: Shape - Oval
Eyes - Shallow
Skin Color - Creamy White
Skin Texture - Smooth
Flesh Color - White
Flesh Texture - Somewhat wet
Flower Color: Light purple with white tips
Specific Gravity: Medium
Susceptibilities: Susceptible to common scab.
Storability/Dormancy: Early maturing and not considered a long-term storing potato.

Yukon Gold

Primary Use: Fresh Market
Maturity: Mid-season
Tuber: Shape - Round
Eyes - Shallow
Skin Color - White
Skin Texture - Smooth
Flesh Color - Yellow
Flesh Texture - Dry and mealy
Flower Color: White
Specific Gravity: High
Resistances: Resistant to mild mosaic and moderately resistant to virus leaf roll.
Susceptibilities: Moderately susceptible to common scab and virus Y.
Storability/Dormancy: Stores well, long dormancy.

Seed treatment

Seed-piece decay and surface infections of Rhizoctonia and common scab on tubers can be controlled by seed treatment. Seed treatment will not protect the developing plant from other infections carried within the seed piece or from disease organisms that live in the soil.

For best results cut, treat and plant seed the same day. Do not hold treated seed for more than 12 to 24 hours. If cut seed cannot be planted the same day then maintain the seed at 10-15°C and a high relative humidity for 3-4 days to allow the cut surfaces to cork over. Never allow cut seed to stand in the hot sun or in drying wind.

Apply dust treatments according to manufacturer's directions or at the rate of 0.4 kg/ac (1 kg/100 kg/ha) of cut seed.

Apply one of the following:
Captan (7.5%)
Captan + Diazinon (1%)
Mancozeb (8.0%)
Easout (5.0%)
Polyram (7.0%).

Planting and spacing

Planting dates will vary from early to late May depending upon local climatic conditions, the variety, and the purpose for which the potato crop is grown. Potatoes should be planted as early as conditions permit, but soil temperatures should be at least 7°C. Cold or wet soils must be avoided if possible, as seed pieces will be subject to rot resulting in poor plant stands.

The equipment used for planting, cultivating, spraying or harvesting will govern the row spacings. Usually rows are 90-106 cm (36-42 in.) apart. The closer spacing is possible when soil moisture and fertility are adequate.

Seed pieces are spaced 23-45 cm (9-18 in.) apart in the row. The wide spacings are desirable when fertility is low and when moisture may be lacking. Close in-row spacing is required for some varieties to prevent over-sizing, growth cracks or hollow heart. Under optimum conditions a close spacing will produce greater yields. A 30 cm (12 in.) spacing has been the most accepted for Russet Burbank with irrigation and 38 cm (15 in.) spacing for dryland production.

No specific depth of planting will give equally good results under all conditions. Planting depths of 7-15 cm (3-6 in.) are commonly used, but it is important for good germination to place the seed in warm, moist soil. Shallower planting is favored on heavier soils where Rhizoctonia has been a problem because quick emergence reduces possibility of infection.

Seed requirements will depend upon between-row and in-row spacings and the size of seed pieces. The following table indicates the amount of seed required to plant an acre at various spacings and with various seed sizes.

Number of hundredweight required to plant one acre

Distance between rows	Space between seed pieces	Size of seed pieces		
		40 g (1.5 oz)	55 g (2 oz)	70 g (2.5 oz)
75 cm (30")	25 cm (9")	22	29	36
	30 cm (12")	17	22	27
	40 cm (15")	13	17	22
	45 cm (18")	11	14	18
90 cm (36")	25 cm (9")	18	24	31
	30 cm (12")	14	18	23
	40 cm (15")	11	14	18
	45 cm (18")	9	12	15
95 cm (38")	25 cm (9")	17	23	29
	30 cm (12")	13	17	21
	40 cm (15")	10	14	17
	45 cm (18")	9	11	14
105 cm (42")	25 cm (9")	16	21	26
	30 cm (12")	12	16	19
	40 cm (15")	10	12	16
	45 cm (18")	8	10	13

Soils

Tuber yield, shape, grade and ease of harvesting are dependent upon the texture and other physical characteristics of the soil. Medium textured to light sandy loam and alluvial silt soils are easy to work, and do not stick to planting or harvesting equipment or to the tubers during wet digging periods. Soils that are high in organic matter tend to ensure good aeration, nutrient supply and water holding capacity. Good drainage is an essential factor of all potato growing soils; poorly aerated water-logged soils restrict the air needed by the roots and promote soft rot. Soils that have produced potatoes infected with diseases such as scab, Rhizoctonia or blackleg should be avoided.

In some areas, potatoes are grown year after year on the same land, with only the occasional use of cover crops. Growing potatoes continually on the same land can lead to a build up of disease and insect problems. Crop rotations, particularly those including a legume, are advisable for potato production. If sod has preceded potatoes, wireworm infestations should be guarded against. Growers renting land should carefully check the cropping history to determine if any special precautions are required.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Fertilizer requirements for potatoes depend on soil type, availability of irrigation, variety and spacing. Potassium may be required on some soils when soil tests show potassium levels to be less than 140 to 180 kg/ac. Potassium may be required when potatoes, sugar beets and malting barley have been grown for a long time.

Response to fertilizer is best when all the fertilizer is applied at seeding time and placed 5 cm (2 in.) to the side and below the seed pieces.

Growers should apply 120 kg/ac of 11-55-0 and 140 kg/ac of 34-0-0 or the equivalent. Potassium may be required if soil tests show that potassium levels are below 180 kg/ac.

Weed control

Roundup (360 g/L glyphosate). Roundup has been an effective before planting fall or spring treatment for control of perennial weeds. It is inactivated by soil contact and therefore does not have any residual activity. Roundup should be applied at recommended rates when weeds are actively growing and at the ideal stage of growth.

Eptam E (800 g/L EPTC). Eptam 8E at 1.7 to 3.4 L/ac can be applied and incorporated before planting in spring, or at drag-off or as a lay-by treatment after crop emergence. Eptam 8 E can also be metered into irrigation water. Fall application is also registered, but not recommended for southern Alberta. Eptam 8E can be impregnated on granular fertilizer or mixed with liquid fertilizer. Eptam requires immediate incorporation. Refer to table 11, page 93 for weeds that are controlled by Eptam. To increase the control of mustards and some other broadleaf weeds, Eptam can be tank mixed with Sencor 5F, Sencor 75 DF and Lexone 75 DF

Lorox L (linuron 480 g/L), Lorox 50 DF (50% dry flowable), Afolan (450 g/L). Apply before potatoes emerge, Lorox L at 0.9 to 1.8 L/ac or Lorox 50DF at 0.9 to 1.8 kg/ac or Afolan F in 1.1 to 2 L/ac in 120 L/ac of water. Refer to table 7, pages 36-37 for list of weeds controlled. It requires irrigation after application.

Sencor 500F, Sencor 750 DF, Lexone 75 DF (metribuzin). Sencor 500F at 225 ml/ac or Lexone 75 DF at 140 g/ac. Apply early postemergence for broadleaf weed control when weeds are small. Under irrigation, higher rates of metribuzin either pre or postemergence are permissible (see label). These products can be tank mixed with Eptam 8E for a PPI application.

Gramoxone (paraquat) 200 g/L. Refer to stale seedbed technique, p. 24.

Hoe Grass 284 EC (284 g/L diclofopmethyl). Apply postemergence for control of wild oats, yellow and green foxtail and barnyard grass. Apply 1.4 L/ac when susceptible annual grasses are in the 1 to 4 leaf stage.

Poast (184 g/L sethoxydim). Apply at the proper rate and growth stage of annual grasses as described in the snap bean section. For quackgrass suppression, apply Poast when quackgrass is in the 2 to 3 leaf stage at 1.78 L/ac. Minimum interval between spraying and harvesting is 80 days. Or, apply Poast at 1.09 L/ac plus 0.8 kg/ac of 100% water soluble ammonium sulphate. Follow with a cultivation 7 days after treatment. Do not allow spray mixture to sit overnight as the active ingredient is hydrolyzed and subsequently inactivated. Assist oil concentrate must be added to all applications of Poast including mixtures with ammonium sulphate. Refer to page 58 for specific rates.

Excel (90 g/L fenoxaprop-ethyl). Apply 1 L/ac for control of certain grasses refer to 94. Water volume of 40 L/ac and spray pressure of 275 kPa is required. Apply spray at 45° angle forward for better spray coverage. Weeds should be actively growing. Interval between application and harvest should not be less than 60 days.

Fusilade (250 g/L fluazifop-butyl). Maximum rate if 0.8 L/ac. Minimum interval between application and harvest is 90 days. It can be tank mixed with Sencor or Lexone. Do not add Agral 90 with the tank mixture. Refer to page 58 for specific rates.

Insect control

Aphid

These insects are normally only a problem in seed fields where they transmit leafroll and other diseases. For more detailed information consult AgriFax 258/625-1 *Insect Control in Potatoes.*

Table 11. List of Registered Herbicides, Rates and Weeds Controlled in Potatoes

Herbicide and Application Timing	Product Rate Per Acre	Weeds Controlled[x] Barnyard grass BG	Green foxtail GF	Kochia K	Lamb's Quarters LQ	Mustards M	Quackgrass QG[y]	Redroot pigweed RP	Russian Thistle RT	Smartweeds S	Volunteer cereals VC	Wild buckwheat WB	Wild oats WO
BEFORE PLANTING													
Dual 960E	0.8-1.1 L	R	R										
Eptam 8E (alone)	1.7-3.4 L	R	R		R		R	R			R		R
Eptam 8E + Lexone DF	1.7-2.2 L + 140-220 g	R	R		R	R		R		R	R		R
Eptam 8E + Lexone L	1.7-2.2 L + 220-345 ml	R	R		R	R		R		R	R		R
Eptam 8E + Sencor 500F	1.7-2.2 L + 225-345 ml	R	R		R	R		R	R	R	R		R
Eptam 8E + Sencor 75DF	1.7-2.2 L + 150-225 g	R	R		R	R		R	R	R	R		R
Eptam 10G	13.8-27.0 kg	R	R		R		R	R			R		R
Lexone DF	140-220 g				R	R		R		R			
Lexone L	220-345 ml				R	R		R		R			
Roundup	0.91-4.9 L	For Control of Perennial Weeds											
Sencor 500F	225-345 ml				R	R		R	R	R			
Sencor 75DF	150-225 g				R	R		R	R	R			
AFTER PLANTING, BUT BEFORE CROP EMERGENCE													
Afolan F	1.09-1.6 L	R		R	R	R		R		R		R	
Dual 960E	0.8-1.1 L	R	R										
Eptam 8E	1.7-2.2 L	R	R		R			R			R		R
Eptam 10G	13.8-18.2 kg	R	R		R			R			R		R
Gramoxone	1.0-1.75 L	Suppresses Perennial Weeds, Kills Annuals											
Lexone DF (irrigated)	260-567 g				R	R		R		R			
Lexone L (irrigated)	400-910 ml				R	R		R		R			
Lorox L	0.91-1.82 L	R			R	R		R		R		R	
Lorox DF	0.9-1.8 kg	R			R	R		R		R		R	
Patoran FL (alone)	1.7-2.21 L	R	R		R	R		R		R			
Patoran FL + Dual 960E	1.7-2.21 L + 0.8-1.1 L	R	R		R	R		R		R			
Sencor 500F	225 ml				R	R		R	R	R			
Sencor 75DF	150 g				R	R		R	R	R			
AFTER CROP HAS EMERGED													
Eptam 8E (Sprinkler)	1.7-2.2 L	R	R		R			R			R		R
Gramoxone	610 ml	Suppresses Perennial Weeds, Kills Annuals											
Lexone L (Dryland)[z]	220 ml				R	R		R		R			
Lexone L (Irrigated)[z]	445-610 ml				R	R		R		R			
Lexone DF (Dryland)[z]	140 g				R	R		R		R			
Lexone DF (Irrigated)[z]	285-390 g				R	R		R		R			
Sencor 500F[z]	225 ml				R	R		R	R	R			
Sencor 75DF[z]	150 g				R	R		R	R	R			

x - R signifies herbicide is registered for control of weed specified.
y - Check label for quackgrass control.
z - Sencor and Lexone can be tank mixed with Fusilade 250EC.
Notes: - Sencor, Lexone, Dual, Gramoxone have varietal restrictions on their labels
- Check label for guidance in selecting a rate when a range in rates is specified.
- Herbicides are not available for control of Canada thistle and perennial sow thistle.
- Recropping restrictions should be noted for Sencor and Lexone.
- Consult Guide to Crop Protection in Alberta, Part I - Chemical for additional information.

Apply one of the following materials:

Pirimor 50 WP at 172 to 222 g in 200 to 400 L of water/ac (7 days), or

Furadan 48 SN at 445 ml/ac (7 days), or

Belmark 30 EC at 90 to 130 ml in 180 to 220 L of water/ac (7 days), or

Alternative chemicals and formulations: Lagon 480 E (7 days); Thiodan 40 EC, 50 WP (1 day); Malathion 4 DU, 50 EC, 25 WP, 85 EC (3 days); Phosdrin 60 SN (1 day); Monitor 48 SN (14 days); Temik 10G (90 days); Imidan 50 WP, 70 WP (7 days); Lannate (Nudrin) 21.6 SN, 90 WP (3 days); Systox 24 EC, 72 EC (21 days); *Di-Syston 72 EC, 15 G (90 days); Diazinon 50 WP, 50 EC (14 days); Guthion 50 WP, 12 EC, 24 EC (7 days); Metasystox 24 EC (7 days); Thimet 15 G (P).

*NOTE: Di-Syston: Use only on seed potatoes.

Colorado potato beetle

Adults are black and yellow striped; beetles overwinter and lay orange egg "rafts" on undersides of leaves. Larvae are brick red with 2 rows of black spots on either side. They also feed on foliage.

Apply one of the following materials, alternating between chemical groups:

Belmark 30 EC at 40 to 60 ml in 90 to 200 L of water/ac (7 days), or

Furadan 48 SN at 445 ml/ac (7 days), as a foliar spray or 10 G formulation at 13.6 kg/ac on 90 cm (36 in.) row spacing or

Decis 5 EC at 40 to 60 ml in 80 to 200 L of water/ac (23 days). No more than 3 applications/year or,

Ambush 500 EC at 57 to 80 ml/ac (1 day) or,

Supracide 25 EC at 445 ml/ac (14 days) or,

Guthion 50 WP at 220 to 345 g/ac (7 days) or,

Monitor 48 SN at 710 to 910 ml/ac (14 days) or,

Thiodan 4 E, 40 EC at 565 ml/ac (1 day).

Alternative chemicals and formulations: Guthion 12, 24 EC (7 days); Sevin 5 DU, 50 WP, 80 WP, 85 WP (7 days); Temik 10 G (90 days); Birlane 40 EC (7 days); Diazinon 50 WP, 50 EC (14 days); Di-Syston 15G, 72 EC (90 days); Lorsban 40 EC (7 days); Dasanit 15G, 72 EC (100 days); Malathion 4 DU, 50 EC, 25 WP, 85 EC (3 days); Methoxychlor 50 WP, 24 EC (7 days); Dibrom 86.4 EC (4 days); Imidan 50 WP, 70 WP (7 days); Thimet 15G (P), Vydate L 24 SN (7 days); Cymbush 250 EC (7 days).

Tuber flea beetles

They are small, dull-black beetles that chew shot holes in the foliage from mid-June onward. Larvae tunnel into the tubers a short distance producing surface tracks and tiny corky plugs.

These beetles have been confirmed in many areas of Alberta, primarily urban areas. They are a serious pest in British Columbia, but their damaging potential in commercial fields in Alberta is not yet known.

All of the materials listed under Colorado Potato Beetle will give control of tuber flea beetle, except Di-Syston. Most controls are applied primarily against adult beetles.

Wireworm

Yellowish-brown shiny "worms" which may chew into seed-pieces, crowns and tubers. They are most likely to be a problem the first two years after sod-breaking. They can be controlled by planting seed-treated cereals for 2 years before planting potatoes or applying one of the following materials:

Dyfonate 10G at 22.7 kg/ac broadcast pre-planting. Incorporate into the soil to a depth of 15 cm. or,

Dyfonate 10G at 9.0 kg/ac as an in-furrow band treatment at seeding. Use only on irrigated soil. or,

Furadan 5G at 44.5 kg/ac as a pre-plant broadcast, or 27.3 kg/ac as a band treatment at planting.

Alternative chemicals and formulations: Dasanit 15G (100 days); Thimet 15G (P).

Aster leafhopper

Small, pale yellow leafhopper that feeds on many crops and transmits aster yellows mycoplasma, of importance only to seed growers. Avoid growing potatoes near legumes, cereals or grassy headlands. Rogue out infected plants.

Leafhoppers are usually blown in from the United States from mid-June onward.

Sprays applied for potato aphid control, with the exception of Pirimor, will also control leafhoppers. In addition Ambush 500 EC at 57 to 80 ml/ac (1day), Cygon 480E at 225 to 450 ml/ac (7 days), Cymbush 250 EC at 57 ml/ac (7 days) or Furadan 10G at 13.6 kg/ac using 90 cm (36 in.) row spacing may be used.

Disease control

Bacterial ring rot

Plant whole, certified seed potatoes if available. If cut seed is being used, disinfect cutting knives frequently. Plant with a cup-type planter. Clean and disinfect potato storage annually and potato equipment as often as is feasible. Disinfect cutting knives frequently. For disinfection use one of the following:

	Amount per L of water	gal of water
Quaternary ammonium compounds	13 ml	.10 fl oz
50% Lysol	100 ml	.77 fl oz
Household Bleach	100 ml	.77 fl oz
Formalin	25 ml	.20 fl oz.

Bacterial soft rot

Control other tuber diseases with which soft rot is usually associated. Avoid mechanically injuring or freezing the tubers. Store tubers under proper conditions.

Blackleg

Plant whole seed that is free from blackleg. Clean and disinfect potato storage areas annually and potato equipment as often as is practical with formaldehyde 37 SN 1.25 L/10 L (1 pt/gal). Remove rotted tubers from seed stocks during grading.

Common scab

Use a 3-5 year rotation, preferably with legumes. Plant scab-free or treated seed on land free of scab. Use acidic fertilizers such as ammonium sulphate (21-0-0). Irrigate adequately, especially at the time of tuber initiation. Do not add large amounts of manure to potato soil. Do not burn refuse in potato fields. Chieftan, Russet Burbank (Netted Gem), Norchip, Norgold Russet, Norland and Viking are moderately resistant to scab. Treat seed pieces at planting with Captan 50 WP 3 kg/1000 L (3 lb/100 gal)--dip seed, Polyram 7, 1 kg/100 kg (1 lb/100 lb) of seed--dust seed or formaldehyde 37 SN 450 mL/100 L of water (0.45 gal/100 gal of water)--soak seed. Crops such as sugar beets also host the causal agent of scab.

Dry rot

Treat seed pieces at planting (see Seed piece decay). Harvest during dry, cool weather, and avoidbruising tubers. Store tubers for 7-10 days at 15°C to favor wound healing. Maintain humidity at 90% with adequate air circulation. Irish Cobbler and Kennebec are resistant to dry rot. Tubers going into storage can be treated with Mertect 450 F at 8 L/170 L (4.7 gal/100 gal). Apply 2 L spray mix/1000 kg (2 qt/2500 lb) of potatoes.

Early blight

Remove and then burn severely diseased vines. Maintain soil moisture and fertility. Avoid potatoes, tomatoes or eggplants in the crop rotation for at least two consecutive years. Use seed potatoes free of the disease. Spray the foliage with a fungicide when the disease appears and continue at 10-day intervals or frequently enough to prevent the disease from becoming severe. Use Dithane M-45 80 WP or Manzate-200 80 WP at 0.4 to 1.3 kg/ac (1 day), Dithane 75 DG 0.7 to 0.9 kg/ac (1 day), Polyram 80 WP at 0.4 to 0.8 kg/ac (1 day), Difolatan 4.8 F at 1.7 L/ac (1 day), or Bravo 500 at 0.6 to 1.0 L/ac (7 days).

Rhizoctonia (black scurf)

Plow down a green cover crop the year before planting if black scurf has been a problem in previous years. Use disease-free seed. Avoid planting in cold, wet soil and cover seed pieces with not more than 5 cm (2 in.) of soil.

Harvest tubers as soon as they are mature. Avoid growing potatoes in fields or portions of fields where the disease has been severe. Treat seed pieces with Captan 50 WP 3 kg/1000 L (3 lb/100 gal of water)--dip seed, formaldehyde 37 SN 450 ml/100 L (.45 gal/100 gal)--soak seed, or Mertect 450 F at 8 L/170 L (4.7 gal/100 gal)--spray 2 L of mixture/1000 kg (2 qt/2500 lb) of potatoes.

Seed piece decay

Cut, treat and plant the seed the same day. If cut seed cannot be planted the same day, maintain it at 10-15°C and high humidity. Don't allow cut seed to be exposed to the hot sun or drying winds. Whole seed is less prone to decay than cut seed. Treat seed before planting with Captan 50 WP 3 kg/1000 L (3 lb/ 100 gal water)--dip seed, Captan 7.5 D + Diazinon 1% D 1 kg/100 kg (1 lb/100 lb), Mancozeb 8 D 1 kg/100 kg (1 lb/100 lb), Polyram 7 1-1.7 kg/100 kg (1-1.5 lb/100 lb) or Easout 5 D at 1 kg/100 kg (1 lb/100 lb). Store treated seed under well ventilated conditions.

Plant seed pieces well away from bands of insecticide or liquid fertilizer.

Leaf roll

Use certified seed. Rogue infected plants. Control aphids (see Insects). Vine kill seed potatoes

when green peach aphids first appear or as early as possible.

Mosaics

Control viruses X, Y, A and S as outlined in leaf roll control.

Special problems

Seed selection

Selection of high quality seed stock is necessary for maximum yields of commercial potatoes. Characterisitics of high quality seed are trueness to variety, freedom from seed-borne diseases, physical soundness and an approved field inspection report. The seed should have been produced under suitable growing conditions and stored at temperatures of 3-5°C. Commercial growers should always use seed that is relatively free from disease, e.g. foundation or certified. Many diseases that reduce the yield of potatoes do not produce visible symptoms on the outer surface of the tubers; this is particularly true of bacterial and virus diseases. A plant from an infected seed piece can serve as a source of infection for the spread of diseases to other plants in the field through insects or mechanical contact. Therefore, good seed is an economic asset.

Cultivation and handling

The basic reasons for cultivation of potatoes are weed control to prevent greening of the tubers and to enhance soil aeration. Early cultivation is desirable to control germinating weeds and to provide loose soil for later hilling operations. The rolling type of cultivator is well suited to early cultivating operations. If such a unit is not available, a light hilling followed by harrowing will destroy most weed seedlings before potatoes emerge. Later cultivation should be shallow to avoid damaging the developing root system. It is important to cultivate after irrigating to aerate and condition the soil. The number of cultivations necessary for weed control will likely decrease as selective herbicides are more commonly used.

The last one or two cultivations may be combined with hilling or ridging. Hilling is done to cover tubers to prevent them from greening, to prepare furrows for irrigation and to protect the potatoes from frost preceding the harvest. Hilling is particularly important when furrow irrigation is used or shallow setting varieties are grown.

Vine killing

Vines are killed to hasten maturity, to facilitate mechanical harvesting and to prevent movement of leaf diseases to the tubers.

Vine killing affects tubers in several ways:
1) Maturity is artificially hastened and harvest injury reduced.
2) Slow killing permits translocation of food from the tops and increases dry matter levels of the tubers.
3) Rapid killing cuts off food supplies to the tubers, lowers quality, and may cause stem-end discoloration.

Vine killing should be done 10 to 14 days before the desired harvest date. For a main crop variety, the treatment should be delayed as long as possible to increase yield and should not be applied over the entire field at one time but in sections of a few hectares (acres) to allow further growth of unharvested plants.

Mechanical and chemical vine killers can be used alone or in combination. Flail-type beaters kill vines instantly and machines must be adjusted carefully to minimize tuber injury. Chemicals for vine killing are Reglone (diquat), Dow Potato Top Killer (dinoseb) and Topper (dinoseb). Speed of killing by chemicals depends upon density of foliage, vine ripening, rate of application, temperature and the characteristics of chemical.

CAUTION: Vine killing chemicals are TOXIC. Read the label. Use recommended rates, and take all necessary precautions.

Harvest timing

The decision as to when to dig is often influenced by such considerations as market prospects, suitable weather, level of mechanization and availability of labor. The proper time for harvesting potatoes should be determined chiefly by the maturity of the crop.

If the crop is fully matured before harvesting, the skin of the tubers will "set" after the vines die and there is less likelihood of skinning and bruising. Even when harvesting a mature crop, however, precautions should be taken to avoid mechanical damage by padding the chains and elevators on the harvester, by providing a constant flow of potatoes and soil on all chains and by handling the potatoes carefully.

Mechanical injury

Special attention should be given to the proper adjustment of all conveyors and drops. Bruises are not always noticeable at harvest, but

may show up after storage and result in heavy losses by lowering the grade and increasing the number of culls. Considerable knowledge and practical experience plus constant alertness and skill are required to operate any machine properly to obtain the best possible performance with a minimum of damage to the crop. Mechanical harvest injuries result in large economic losses annually to potato growers. Bruising also increases the susceptibility of tubers to diseases.

Sprout inhibition

Year-round marketing of potatoes has become a reality with the development of modern storages and of effective sprout inhibitors. At present, there are two chemicals available for use. They are maleic hydrazide, and CIPC. Maleic hydrazide is sold under many trade names such as Royal MH60SG, De-Sprout V, Gro-Tard, MH 30, Retard, Slo-Gro, Sprout-Stop and Malazide.

Maleic hydrazide is sprayed on the potato plant anywhere from one to three weeks after full bloom. Timing and uniform coverage are very important; therefore, read the label carefully before using. CIPC can be applied in storage as a fog or as a spray after washing. If CIPC is applied as a fog, ducts should be placed in the storage before potatoes are harvested, these ducts also serve to ventilate the potato storage. For further information regarding custom application of CIPC consult with your district agriculturist. It should be kept in mind that chemical sprout inhibitors cannot take the place of proper storage management and should only be used as a supplement to good storage practices.

CAUTION: Do not use sprout inhibitors on or near potatoes to be used for seed. Even in small quantities these inhibitors will adversely affect germination. Do not store seed potatoes in storages that have been treated with CIPC in the past.

Seed production

The production of potato seed requires a high degree of knowledge and management ability. Refer to Agri-Fax 258/13-1, *Seed Potato Production in Alberta* or contact the potato production specialist listed on the back cover of this guide.

Storage and handling

Storage requirements for potatoes vary considerably depending on variety, intended markets and condition of the potatoes.

Refer to Agdex 258/20-8, Potato Production Guide for details on potato storage requirements.

Grade and packaging standards

The following is a guide and has no official sanction.

The grades for potatoes are Canada No. 1, Canada No. 1 large, Canada No. 1 small and Canada No. 2.

Canada No. 1 is the grade name for potatoes that: have similar varietal characteristics; are firm; are not seriously pointed, dumb-bell shaped or otherwise deformed; have skins that are well set; have no more than 10% of a lot that has more than 10% of surface flesh exposed; are reasonably clean; are free of specimens from which knobs have been removed; blight, bacterial ring rot or other decay; are free from damage (which is specifically defined); have, in the case of round varieties, a minimum diameter of 5.6 cm (2.25 in.) and a maximum diameter of 8.9 cm (3.5 in.) and in the case of long varieties have a minimum diameter of 5 cm (2 in.) and a maximum diameter of 8.9 cm (3.5 in.), except in the case of tubers longer than 8.9 cm (3.5 in.) which may have a diameter of 4.5 cm (1.75 in.) provided that in either case 60% of the specimens have a diameter of at least 5.6 cm (2.25 in.) and are properly packed.

Canada No. 1 large is the grade name for potatoes that have a minimum diameter of 7.6 cm (3 in.) and a maximum diameter of 11.4 cm (4.5 in.), but in all other respects comply with the requirements of Canada No. 1 grade.

Canada No. 1 small is the grade name for potatoes that have a minimum diameter of 3.8 cm (1.5 in.) and a maximum diameter of 5.6 cm (2.25 in.) but in all other respects comply with the requirements of Canada No. 1 grade.

Special considerations are provided for new potatoes; round varieties shipped before September 15 in any year that do not meet maturity and size requirements, and new potatoes of a long variety shipped before June 30 that do not meet maturity or size requirements and between June 30 to September 15 that do not meet maturity requirements, but in all other respects meet the requirements of Canada No. 1 grade, may be designated as Canada No. 1, provided they have a minimum diameter of 4.8 cm (1.87 in.).

A series of general tolerances apply to all Canada No. 1 grades. Five percent by weight may be below minimum size, 5% may exceed maximum size; 3% of potatoes by weight (5 % for Canada No. 1 large) may be affected by hollow heart; 1% may be affected by decay; 5% may have grade defects other than size or hollow heart, but including decay and 10% of the potatoes may have grade defects of

any kind including all previously identified and still meet grade requirements.

Canada No. 2 grade potatoes are potatoes with similar varietal characteristics; are reasonably firm; are not seriously pointed or dumb-bell shaped; are free from decay; are free from damage (damage is specifically defined); have a minimum diameter of 4.5 cm (1.75 in.) and a maximum diameter of 11.4 cm (4.5 in.); have a diameter not less than 5 cm (2 in.) in 75% of the weight; have not more than one third of the lot by weight seriously affected by dirt and are properly packed.

General tolerances also exist for Canada No. 2 grade potatoes with higher tolerances for hollow heart and defects than in Canada No. 1.

Package sizes for potatoes are 2.27 kg (5 lb), 4.54 kg (10 lb), 9.07 kg (20 lb), 22.7 kg (50 lb), 34 kg (75 lb) 45.4 kg (100 lb) and 50 kg (110 lb) bags or cartons.

Radish

Varieties

Champion, Cherry Belle, Comet, Icicle (white)

Seed treatment

Purchase hot-water treated seed and seed that has been treated with Thiram or Captan seed treatment.

Seeding and spacing

Seed as early as possible. Continue planting at 1-2 week intervals until August 15 or September 1 to assure continued supply. Sow 1 cm (0.5 in.) deep. Plant rows 20-30 cm (8-12 in.) apart and space seeds at 40-45 per metre (12-15/ft). Four to 7 kg/ac of seed are required.

Row spacing and seeding rates will have to be adjusted to accommodate a mechanical harvester.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Before planting, broadcast and work in 55 kg/ac of 11-55-0 and 45 kg/ac of 34-0-0 or the equivalent.

Weed control

Plant into clean seedbed. Shallow cultivation may be necessary. No herbicides are registered for use in radishes.

Insect control

Flea beetle

They are small black or black and yellow hopping beetles that chew shotholes in cotyledons and foliage. Treatment for root maggots should also control flea beetles.

If necessary apply one of the following materials:

Diazinon 50 EC at 445 ml/ac (10 days) or,
Diazinon 50 WP at 445 g/ac (10 days) or,
Malathion 4 DU at 13.4 kg/ac (7 days) or,
Ambush 50 EC at 56.7 ml/ac (2 days).

Alternative chemicals and formulations: Sevin 50 WP, 85 WP (7 days); Methoxychlor 50 WP, 24 EC (7 days).

Root maggot

Grey flies lay eggs at base of young plants. White legless maggots chew into roots. Treatment is necessary in most areas of Alberta.

At seeding, apply an in-furrow granular treatment of Diazinon 5G at 175 g/100 m of row (18.0 kg/ac) at 38 cm (15 in.) row spacing. Ten and if necessary 20 days later drench with Diazinon 50 EC at 445 mL/ac (10 days).

Disease control

Damping-off

See cabbage disease control.

Storage and handling

Radishes store best at 0°C and humidity greater than 95%. Radishes have a storage life of 10-14 days. Field heat should be removed as quickly as possible.

Grade standards

There are federal regulations for radishes.

Growers should only offer top quality radishes for sale. Generally radishes should be fresh; firm and not pithy; uniform in size, shape and color; clean; free from damage and decay. Bunched radishes should have fresh, green leaves; should not be wilted; free from insect damage.

RHUBARB (Field)

Varieties

Early Sunrise, MacDonald, German Wine (processing)

Soils, planting and spacing

A well-drained, but moisture-holding soil is required. Lighter soils will produce an earlier crop but will require more frequent irrigation. Fields should be summerfallowed prior to planting to eliminate perennial weed infestations. The field should be deep ploughed in the summer and the seed-bed prepared in advance of planting crowns.

Plants for propagation should be selected in the summer months when growing vigorously. Virus infection and other diseases reduce yield and vigor of rhubarb plants. Healthy, vigorous 3 or 4 year old crowns should be selected and divided to obtain three or more buds per seed piece.

Planting of crowns can be done early in spring or late in the fall when crowns are dormant. Crowns should be planted 7 to 10 cm (3 to 4 in.) deep, 90 cm (3 ft) apart in rows and rows should be spaced 90 to 120 cm (3 to 4 ft) apart.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Before planting, 12 to 24 t/ac of manure should be broadcast and ploughed into the soil.

In the year of planting, apply 70 kg/ac of 34-0-0 and 80 kg/ac of 11-55-0 or the equivalent.

In subsequent years apply 120 kg/ac of 34-0-0 and 80 kg/ac of 11-55-0 or the equivalent.

Check fertility levels with annual soil tests.

Apply 10 t/ac of well rotted manure every 3 to 4 years. Nitrogen rates may be reduced in the year manure is applied.

Weed control

Plant into a clean field free of perennial weeds. No herbicides are registered for use in rhubarb.

Disease control

Red leaf (crown rot)

Use disease-free crowns for planting. Dig out and destroy plants with red leaf symptoms. Harvest healthy plants first and diseased plants last to avoid spreading red leaf pathogens on harvest equipment. Do not replant in spots where diseased plants have been removed. Keep stands vigorous and avoid unnecessary injury to the crowns during cultivation and harvesting operations.

Special problems

To maintain good plant vigor, flower stalks should be cut and removed while still small.

Harvesting

Stalks should not be harvested during the first year of growth. In Alberta two major harvests can take place in early June and about mid July without affecting next year's crop. Stalks should be pulled and not cut. Leave a few leaves on each crown after harvest and if possible irrigate immediately.

RUTABAGAS (Swede Turnips)

Varieties

Laurentian, Alta Sweet

Seed treatment

Purchase hot-water treated seed that has been dusted with Captan or Thiram.

Seeding and spacing

Seed rutabagas for early market as soon as possible in the spring. Plant rutabagas for storage from June 15 to July 10. Seed 1-2 cm (0.5-1 in.) deep. Use appropriate sized seed and sow with a precision seeder that will drop single seeds at a 12 cm (5 in.) spacing. Thinning is not required with a precision seeder. Approximately 0.2 kg/ac of seed is required.

Approximately 0.8 kg/ac of seed is required if seeded with a drill-type seeder. Space rows 60-76 cm (24-30 in.) apart. Closer row spacing may be more productive, however, tops may bind at harvest time.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Before planting, broadcast and work in 90 kg/ac of 11-55-0 and 45 kg/ac of 34-0-0. Excessive nitrogen levels will reduce root quality because rapid growth may cause root cracking.

Boron deficiency has been seen in some rutabaga crops in Alberta. Boron deficiency causes water core or brown heart. This may occur in the field or show up in storage. Boron deficiency is likely to occur in soils where pH is greater than 6.5. Boron may be added to the granular fertilizers prior to planting or applied as a foliar spray when roots are about 2 cm (1 in.) in diameter. Add about 4 to 12 kg/ac of agricultural borax to the granular fertilizer. In addition or as an alternative, spray rutabagas with 0.2 to 0.4 kg/ac of Solubor or Boro-spray following manufacturer's directions.

Boron is only required in small quantities, and an overdose may be toxic to crops following rutabagas. Care should be taken in its use. Do not plant legumes or cucumbers the year following boron application.

Weed control

Members of the mustard family such as stinkweed, wild mustard, shepherd's purse and volunteer rapeseed cannot be chemically controlled in rutabagas.

Treflan (545 g/L trifluralin) 0.6 to 0.8 L/ac, Rival (500 g/L trifluralin) 0.65 to 0.89 L/ac. Use the lower rate on sandy soils with less than 6% organic matter. Apply in 40 L/ac of water as a preplant incorporated treatment. Incorporate within 24 hours of application into soil in two different directions or in one direction with a rotovator. Incorporation can also be accomplished with a tandem disc, disker or field (vibrashank type) cultivator set to work 8 to 10 cm (3 to 4 in.) deep. As a precautionary measure, do not plant red beets, sweet corn, vine crops, oats and small seeded annual grasses in rotation following use of trifluralin.

Eptam (800 g/L EPTC). Apply and incorporate six to ten days before planting. Apply 1.3 to 1.7 kg/ac in 40 L/ac of water. Eptam is not persistent in the soil; it will give effective weed control for approximately six to eight weeks.

Insect control

Flea beetle

The same black beetles that attack radishes and cole crops also attack rutabagas. Only the seedling plants need to be protected.

Apply one of the following materials:

Diazinon 50 EC at 445 ml/ac (14 days) or

Thiodan 50 WP at 710 g/ac. Do not apply more than twice per season. or,

Furadan 48 SN at 35 ml in 10 L of water/100 m of row (0.5 fl oz in 100 gal/150 ft of row) or 2.0 L in 525 L of water/ac at 70 cm (28 in.) row spacing (40 days).

Counter 15-G (terbufos) at 10 kg/ac with 61 cm (24 in.) row spacing, 8.5 kg/ac with 71 cm (28 in.) row spacing and 7.5 kg/ac with 81 cm (36 in.) row spacing. Apply at seeding time. Place granules in a 15 cm (6 in.) band over the row and incorporate shallow for early season infestations. Late season infestations will require supplemental control measures.

Alternative chemicals and formulations: Diazinon 50 WP (14 days); Furadan 48 SU (40 days); Thiodan 40 EC (45 days); Methoxychlor 50 WP, 24 EC (7 days); Ambush 50 EC (3 days).

Imported cabbageworm, Diamondback moth

Green caterpillars chew holes in leaves. Where numerous, apply one of the following materials:

Dipel WP at 220 to 445 g/ac. No wait period. Use a sticker and repeat at 7 to 10 day intervals as necessary. Apply when caterpillars are small or,

Dylox 80 SP at 280 to 610 g/ac (28 days) or

Sevin 50 WP at 0.9 to 1.8 kg/ac (14 days).

Alternative chemicals and formulations: Counter 15-G (0 days); Dylox 42 SN (28 days); Sevin 48 SU, 43 SU, 85 WP (7 days); Malathion 4 DU (7 days).

Root maggot

The adult form is a grey-black fly that lays eggs at base of young plants from early June to early July and again during August. The white, legless larvae mine roots and introduce rot organisms, rendering roots unmarketable. Preventative control measures will be necessary in most areas of Alberta. Locate crops away from canola which is an alternate host. Keep cruciferous weeds under control.

Apply one of the following materials using a combination of granular at seeding + foliar, or liquid at seeding + foliar. It is important to protect the crop during both first and second adult fly periods. When possible, seed early and harvest by first week in August.

Granular:

Dasanit 15G at 125 g/100 m (1.5 oz/100 ft) of row to a maximum of 7.0 kg/ac (40 days). Apply in 10 to 15 cm (4 to 6 in.) band prior to seeding. Cultivate into top 2 to 5 cm (1 to 2 in.) of soil then seed into centre of band. Use liquid formulations for follow up sprays (outlined later) or,

Furadan 10G at 175 g/100 m (2.0 oz/100 ft) of row or 10 kg/ac with 70 cm (28 in.) row spacing (40 days). Apply in 10 cm (4 in.) band on the soil surface in front of the planter shoe and incorporate while seeding. Use a liquid formulation for subsequent sprays (outlined later) or,

Alternative chemicals and formulations: Thimet 10G, 15G (P). In other provinces, Birlane 10G (40 days).

Liquid:

Dasanit 72 EC at 25 mL in 10 L water/100 m of row (0.3 fl oz in 1 gal water/100 ft of row) to a maximum of 1.72 L/ac (40 days). Apply in 15 cm (6 in.) band after seeding and make a second application 4 weeks after planting. Make 1 or 2 additional sprays if required applying as a drench to wet crown of plant and 7.5 cm (3 in.) of soil on both sides of row. Do not apply more than 4 times in a season, or

Furadan 48 SN at 35 ml in 10 L water/100 m of row (0.4 fl oz in 1 gal/100 ft of row) or 2.0 L in 525 L of water/ac (40 days) at a 70 cm (28 in.) row spacing. Apply after seeding but before emergence as a coarse spray in a 10 cm (4 in.) band over the row. Repeat twice as necessary at 3 week intervals.

Alternative chemicals and formulations: Furadan 48 SN (40 days); Guthion 50 WP, 24 EC (35 days). In other provinces, Birlane 40 EC (40 days).

In trials in the Edmonton area, Furadan EC and Burlane EC gave good control applied as a drench at 3 week intervals, whereas Dasanit EC, Guthion WP and Lorsban EC applied similarly gave poor control.

Disease control

Blackleg and black rot

Use hot water treated seed (see the section on Seed treatment). Follow a 4 to 5 year rotation with noncruciferous crops. Do not apply manure containing rutabaga refuse or diseased rutabagas to land intended for production. Avoid storing diseased roots. Clean and disinfect storages each spring.

Soft rot

Avoid bruising roots as much as possible in cultivation and harvesting. Harvest under dry conditions if possible. Store at close to 0°C and 90-95% RH. Disinfect storage bins with steam, copper sulphate (2% solution) or formaldehyde 37% SN at 2.5 L/100 L (2.5 gal/100 gal) of water, prior to harvest.

Water core (brown heart)

In light, sandy soils or where boron deficiency has occurred in the past, broadcast and disc in 4 to 12 kg/ac of agricultural borax (11% boron) prior to planting. If deficiency occurs after planting, immediately apply Solubor or Borospray (21% boron) at 200 to 400 g/ac using 499 L/ac of water as a foliar spray. Do not plant legumes or cucumbers the year following application of boron.

Wire stem (crater rot)

Avoid injury to roots in the field and during harvest. Harvest under dry conditions if possible. Store close to 0°C and 90-95% RH. Disinfect storage bins prior to harvest (see Soft rot).

Special problems

2,4-D damage

Rutabagas are sensitive to 2,4-D and although damage or symptoms of 2,4-D spray drift may not show on the top growth the root development can be affected.

Care should be taken to place rutabaga fields away from grain crops that will be sprayed with 2,4-D.

Storage and handling

Rutabagas store best at 0°C and relative humidity of 95% or greater.

Rutabagas should store for 6-7 months at 0°C and relative humidity 95% or greater. Rutabagas can be stored in bulk or in tote bins.

Careful handling to avoid bruising will result in longer storage life. All tops must be removed prior to storage.

Grade and packaging standards

The following is a guide and has no official sanction.

The grade for rutabagas is Canada No. 1. Canada No. 1 rutabagas have similar varietal characteristics; are firm; are reasonably regular in contour and of a length not more than one and a half times the diameter; are trimmed so that tops do

not exceed 19 mm (0.75 in.) and all green leafy growth has been removed and secondary roots and rootlets have been removed; are not trimmed on the upper half of the root or deeply into the flesh on the lower half; are free from insects, insect larvae, decay and damage (damage is specifically defined); have when in a package a minimum and maximum diameter as marked on the package, or have the word 'small' marked on the package where minimum and maximum diameters are 5 cm (2 in.) and 10 cm (4 in.); the words 'small medium' marked on the package where minimum and maximum diameters are 7.5 cm (3 in.) and 14 cm (5.5 in.) prior to August 31 and minimum and maximum diameter of 8.9 cm (3.5 in.) and 14 cm (5.5 in.) after August 31; the word 'medium' marked on the package where minimum and maximum diameters are 10 cm (4 in.) and 15 cm (6 in.); have the word 'large' marked on the package where minimum and maximum diameters are 12.7 cm (5 in.) and 18 cm (7 in.); except in the case of the 'small medium' size until August 31 each year when in a package do not vary more than 5 cm (2 in.) in diameter; and are properly packed.

The additional designation "waxed" may be used in connection with clean, dry rutabagas that have been completely immersed in a wax solution.

General tolerances allow that 10% of the rutabagas by count may be below the minimum size but that none can be more than 1.3 cm (0.5 in.) below the minimum, a similar tolerance applies to maximum size; 5% may be affected by decay; 10% of the rutabagas may have grade defects not including those related to size and still meet the grade standards.

Package sizes for rutabagas are 907 g (2 lb) and 2.27 kg (5 lb) bags, as well as 11.3 kg (25 lb) and 22.7 (50 lb) bags or cartons.

TOMATOES, PEPPERS, EGGPLANT

Varieties

Bush tomatoes: Swift, Rocket (early), Blazer, Valarie, Cherrio (cherry)

Staking tomatoes: Ultra Sweet, Ultragirl

Peppers (hot): Hungarian Yellow Wax (yellow pointed), Red Cherry (green)

Peppers (sweet): Goldie and Giant Szegedi (yellow bell pointed), Early California Wonder (green bell), Super Set (green bell), Golden Summer (yellow bell), Gypsy (yellow pointed, long).

Eggplant: Dusky

Seed treatment

Purchase hot-water treated seed and seed treated with Thiram and Captan.

Seeding and planting

Start tomatoes, peppers and eggplants 6-8 weeks prior to field setting. Germinate at 20-25°C and grow seedlings at 18-27°C during the day and 15-18°C at night. Germinate in flats containing a peat-vermiculite mixture. When seed leaves are fully developed into first true leaves (about 10 days) prick out into flats at 5 cm (2 in.) spacing or into peat pots or other seedling containers.

Plants should be hardened prior to field setting by withholding water or lowering the growing temperature.

Plant into the field after all danger of frost has passed. A preferred and more productive method is to field set tomatoes from May 15-25 and protect them with hotcaps. Peppers and eggplants are best grown under plastic tunnels. Refer to Section 1 of this guide for details on how to use hotcaps and plastic tunnels.

Transplants can be hand planted or set with a mechanical transplanter.

Water-in transplants using a solution of 10-52-10 starter fertilizer. Use 110 (4 oz) per plant of solution of 2 kg (4 lb) of 10-52-10 per 230 L (50 gal) of water.

Spacing

Tomatoes: 60-90 cm (24-36 in.) between rows
45-60 cm (18-24 in.) between plants

Peppers: 45-75 cm (18-30 in.) between rows
30-45 cm (12-18 in.) between plants

Eggplant: 60-90 cm (24-36 in.) between rows
45-60 cm (18-24 in.) between plants

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests. Care should be taken in the application of nitrogen. Too much will cause excessive vegetative growth,

delayed maturity, or lack of fruit set. Before planting, broadcast and work in up to 140 kg/ac of 11-55-0 and 110 to 150 kg/ac of 34-0-0 or the equivalent.

At time of transplanting, add 280 ml (4 fl oz) of a solution of 2 kg of 10-52-10 in 230 L (4 lb in 50 gal) of water or the equivalent.

Weed control

Tomatoes Only - Treflan 545 EC (545 g/L trifluralin, Rival 500 (500 g/L trifluralin). Apply Treflan 545 EC at 0.6 to 0.8 L/ac or Rival 500 at 0.65 to 0.89 L/ac, in at least 40 L/ac of water. Incorporate within eight hours of application according to label instructions. Trifluralin controls green and yellow foxtail, wild oats and several broadleaf weeds (refer to Table 7, pages 36-37), but it will not control plants of the mustard family such as stinkweed, shepherd's-purse and wild mustard.

Tomatoes Only - Poast (sethoxydim). Maximum recommended rate is 1.9 L/ac. The time period between application and harvest should not be less than 50 days. Refer to the section under snap beans, page 58 for more information.

- Fusilade EC (250 g/L fluazifop butyl). Maximum recommended rate is 0.81 L/ac. Refer to page 58 for rates and control of specific grasses. Apply three days before application of any broadleaf herbicides. Add Agral 90 surfactant according to label directions. Minimal interval to harvest is 60 days. Women capable of bearing children should be particularly careful when handling this product.

- Devrinol 50 WP (50% napropamide). Apply and incorporate prior to planting 0.91 to 1.82 kg/ac in 80 to 365 L/ac of water. On the same day of application incorporate to a depth of 2.5 to 5 cm. Devrinol is not recommended for use on soils with more than 10% organic matter. When mixing, make a slurry and add to a nearly filled tank with adequate agitation. Devrinol inhibits the root development of susceptible germinating weeds. It does not control some weed such as nightshade, wild mustard, fleabane and henbit.

Insect control

Aphid

Tomatoes: Soft-bodied sucking insects which cluster on growing tips causing yellowing and wilting. Grow crops away from greenhouses and urban areas where green peach aphids originate.

Apply one of the following materials:

Malathion 25 WP at 0.9 to 2.2 kg/ac (3 days) or,

Thiodan 50 WP at 445 to 600 g/ac (2 days) or,

Systox 72 EC at 110 to 280 ml/ac (3 days pepper and tomatoes, 7 days eggplant).

Alternative chemicals and formulations:

Tomato, eggplant, pepper: Thiodan 40 EC (2 days); Di-Syston 15G, 72 EC (30 to 90 days); Systox 24 EC (3 to 7 days).

Tomato, pepper: Diazinon 50 WP, 50 EC (1 to 5 days); Cygon 48 EC (3 to 7 days); Lagon 480E (3-7 days).

Tomato: Phosdrin 60 SN (1 day); Guthion 50 WP, 12 EC, 24 EC (2 days); Lannate 21.6, 90 WP (1 day).

Pepper: Pirimor 50 WP (3 days).

Colorado potato beetle - Eggplant

Primarily a potato pest but may feed on tomato and eggplant.

Apply one of the following materials: (Tomato, Eggplant)

Thiodan 40 EC at 565 mL/ac (2 days) or,

Sevin 50 WP at 445 g/ac (1 day).

Alternative chemicals and formulations: Sevin 80 WP, 85 WP (1 day); Thiodan 50 WP (2 days); Tomato only, Guthion 50 WP, 12 EC, 24 EC (2 days); Di-Syston 15G, 72 EC (30 days).

Climbing cutworm - Pepper

In Alberta the variegated cutworm chews holes in fruit at night. Caterpillars are large and dark brown. Corn earworm also may damage fruit.

Apply one of the following materials:

Sevin 85 WP at 0.5 to 1.1 kg/ac (1 day) or,

Ambush 50 EC at 57.0 ml/ac (1 day).

Diseases

Bacterial blight - Tomato

Use only hot water treated seed (50°C for 25 minutes). Grow seedlings in steamed or fumigated media in disinfected flats or pots. Remove diseased plants immediately. Avoid spreading bacteria to healthy plants from clothing or tools. Do not use sprinkler irrigation. Do not replant tomatoes for at least 2 years in a field where disease appeared. At first signs of disease in the field spray with Kocide 101 50 WP at 0.9 kg/ac (1 day).

Blossom-end rot - Tomato, Pepper

In acid soils, ensure adequate levels of calcium by adding lime or ground limestone well in advance of planting. Maintain uniform soil moisture

throughout the season. Avoid close cultivation. Apply calcium chloride (36% Ca) at 0.9 to 2.2 kg/ac (2.2 to 5.6 kg/ha) in 1000 L (450 gal) of water as a spray during the fruit development period.

Early blight - Tomato

Plow under crop debris immediately after harvest. Follow a rotation that includes cereals and legumes. A regular spray program at 7-14 dayintervals may be required in some fields. Apply Bravo 500 F at 1.0 to 1.6 L/ac (1 day), Difolatan 4.8 F at 1.1 L/ac (1 day), or Dithane M-45 80WP or Dithane 75 DG at 0.45 to 1.3 kg/ac or Manzate 200 80WP at 0.7 to 1.3 kg/ac (1 day).

Wilt - Tomato

Avoid moving seedlings grown in areas where wilt diseases occur to areas where they are absent. Use only steamed or fumigated media and disinfect flats and pots when growing transplants. Follow a rotation where tomatoes, peppers, eggplants or potatoes have not been grown for at least 2 years. Most commercial varieties have resistance to Fusarium and Verticillium wilts.

Verticillium wilt - Eggplant

For transplant production, sow into steamed or fumigated soil (see Asparagus - Crown rot). Avoid land planted to peppers, tomatoes, potatoes or eggplants for at least two years. Rotate with cereals, grasses or corn.

Special problems

Tomatoes are extremely sensitive to damage from the 2,4-D family of chemicals. Extra care should be taken to prevent fumes of these chemicals from drifting onto the crop from neighboring crop spraying operations.

Storage and handling

Tomatoes, peppers and eggplants should be stored above 7°C to prevent chilling injury. The maximum desired temperature is 10°C. Mature-green tomatoes are more sensitive than ripe, therefore they should be held at 13-16°C. Chilling injury may occur in the field, and its effect is carried over to the storage period. Relative humidity for the storage of these crops is 90% or more. Mature green tomatoes can be stored for up to 6 weeks. Peppers and eggplants can be stored for 8-10 days. Packaging of peppers in perforated plastic bags, or waxing may extend the storage and shelf life.

Grade and packaging standards

The following is a guide and has no official sanction.

The grades for field tomatoes are Canada No. 1, Canada No. 2, Canada No. 1 picklers and Canada No. 2 picklers. Separate grades exist for greenhouse tomatoes. Generally Canada No. 1 tomatoes are sound and clean; have similar varietal characteristics; are not noticeably ridged, angular or indented; are uniform in maturity when packaged; free from disease and damage, scald, water blister, bruises, soft areas, or open wet-cracks; have a minimum diameter of 5 cm (2 in.) or a minimum diamter of 3 cm (1.5 in.) and marked "small"; do not vary more than 2 cm (1 in.) in diameter when packaged.

There are no grade standards for peppers and eggplant but they should be free of disease and damage, have similar varietal characteristics, be evenly sized and neatly packaged.

Package sizes for tomatoes are 397 g (14 oz) tubes, 3.63 kg (8 lb), 4.54 kg (10 lb) and 4.54 kg (10 lb) plus multiples of 2.27 kg (5 lb) cartons, boxes or crates and 4 litre baskets. Tomatoes may also be packed in crates measuring 41 cm (16.12 in.) by 34.3 cm (13.5 in.) by 16.5 cm (6.5 in.) or cartons measuring 40.3 cm (15.87 in.) by 40.3 cm (15.87 in.) by 14 cm (5.5 in.).

SECTION 7
APPENDIX

GLOSSARY OF FREQUENTLY USED TERMS

The following are statements about the usage of terms in crop production and are not necessarily intended as "definitions".

Active ingredient: That portion of a pesticide formulation that is toxic to pests. Most pesticide products contain only a portion of active pesticide--the rest is carrier.

Annual: A plant that grows and normally forms flowers in one growing season or a crop that is planted and harvested in one growing season.

Bacteria: Very small single cell organisms that may attack plants and cause disease. Soil bacteria aid in breakdown of organic matter.

Banding: Placement of fertilizer or pesticide, at the time of planting, in a continuous band to the side and below the seed.

Biennial: A plant that requires two growing seasons to produce flowers. Celery or carrots are grown as annuals for fresh crop production but are biennials when grown for seed.

Bolting: Premature flowering of a plant. Biennial crops like celery normally produce a seed stalk in their second year. Cold temperatures in the growing season can cause bolting.

Broadcast: To spread fertilizer or pesticide over the entire area of the soil surface or the entire crop area before planting.

Carrier: An inert material mixed with active pesticide ingredients to make a pesticide formulation. Example: Finely divided clay or talc is used as a carrier in dust forms of insecticides.

Cultivar: A horticultural classification which means cultivated variety. In most cases cultivars are "man made" as opposed to naturally growing plants, e.g., 'Bonanza' and 'Houston Evergreen' are cultivars of cabbage. The term variety is often used (scientifically incorrectly) in crop production to mean cultivar.

Days-to-harvest: The period of time that must elapse by law between the application of a pesticide and the actual harvest of the crop.

Drift: The undirected and uncontrolled movement of spray mist that occurs at time of spraying, away from application source.

Drill: To place fertilizer or pesticide with or near seed in the seed "drill" or furrow.

Dust: A finely divided carrier containing a pesticide, usually in low concentration, to be used without dilution.

Emulsifiable concentrate: A liquid pesticide consisting of active ingredient, solvent and emulsifier that mixes with water to form an emulsion (e.g., Diazinon 50 EC). The 50 means 50 per cent of the volume is pesticide.

Fertigation: The process of applying soluble fertilizer materials through the irrigation system.

Fertilizer: Any material added to soil or crops that is a source of plant nutrients.

Fumigation: The use of pesticides in a gas form to destroy pests or disease organisms.

Fungi (singular fungus): A large group of simple plants that lack chlorophyll and that require a source of material to live on. Some are parasitic and attack living plants. Soil fungi aid in breakdown of organic matter.

Germination: 1. The beginning of the growth processes of a seed once it is placed into suitable moisture and temperature conditions. 2. A term applied to the number of seeds that will germinate (given in percentage).

Graded or sized seed: Seed that is sorted within a close range of minimum and maximum sizes. The narrow size range of seed is required by precision seeders. (Note: All seed is 'graded' to remove weed seeds, poor seed and impurities.)

Granular pesticide: A pesticide formulation made of relatively coarse particles that is applied dry with a

spreader, seeder, or special applicator (e.g., Diazinon 5G).

Green manure: A crop that is grown and plowed down as a source of organic matter for the soil.

Hardening off: Refers to the practice of preparing tender, indoor-grown seedlings for field conditions, by withholding water or nutrients or by lowering temperature.

Herbigation: The process of applying herbicides through an irrigation system.

Humus: That part of organic matter in the final stages of decomposition which is normally slow to be totally broken down both physically and chemically because of its chemical composition and structure.

Incorporate: To thoroughly mix a pesticide or fertilizer with the soil so that it is uniformly concentrated to a specified depth.

LD 50: Abbreviation for the dose of a pesticide (or other toxicant) that produces a 50 per cent kill of the organism being tested. It is usually expressed as mg per kg of body weight.

Macronutrient: An essential nutrient which is required by plants in large quantity, (e.g., nitrogen, phosphorus).

Micronutrient: An essential plant nutrient which is required by plants in relatively small amounts, (e.g., boron, zinc, manganese).

Mycoplasma: Bacteria-like organisms some of which cause plant diseases.

Nematicide: A pesticide to control nematodes.

Nematode: A very small worm that lives in the soil. Some species may cause severe crop damage by attacking and living in root tissue. Normal sizes range from 0.8-3 mm (1/32-1/8 in.).

Nutrient: A chemical element that is required for crop growth. There are 16 essential elements for crop growth of which 13 are obtained from the soil.

Organic matter: Plant or animal residues in varying stages of decomposition. Undecomposed plant material is normally referred to as 'trash' and doesn't become organic matter until it starts to break down.

Pelleted seed: Seed that is coated with clay, vermiculite or other substances to form uniform round or oval pellets. Irregularly shaped seeds such as carrots and lettuce seed can be coated so that they can be more accurately seeded with precision seeders.

Postemergence: After a crop emerges from the soil.

Precision seeder: A type of seeder designed to accurately place seed at a uniform spacing in the furrow.

Pre-emergence: The time after planting seed but before a crop emerges. Many herbicides are applied after planting but before the crop emerges.

Pricking out: Removal of transplant seedlings, usually at the appearance of the first true leaves, to individual seedling pots or to transplant flats for further growing prior to field setting.

Re-entry time: The minimum time allowed between the time of spraying a pesticide and the time at which the area may be entered by people unless protective clothing and breathing aids are used.

Residue: That portion of pesticide or fertilizer that remains in the soil or on crop plants after application. Amounts of residue decrease with time. Pesticides may leave residues from several hours to several years.

Residue tolerance: The maximum amount of a pesticidal residue that may lawfully be present in, or on, a food product offered for sale. It is expressed in parts per million.

Seed treatment: Chemical or physical treatment of seed to eliminate or reduce organisms that may cause seed decay, seedling death or disease in a growing crop. Chemical treatments include fungicide and insecticide applications to the seed. Physical treatments include immersing seed in hot water.

Side dress: To apply fertilizer in the soil along side of a crop row after the crop is established.

Sized seed: See graded seed.

Spreader sticker: An additive used to improve the efficiency of a pesticide formulation. It may have properties that aid the spreading of a liquid over the leaf and plant surface; it also may enhance the ability of the particles to adhere to the plant surfaces.

Starter solution: A solution made up of water and soluble fertilizer, which is applied at the time of transplanting.

Sterilization: A process of chemically treating or heating transplant soil or greenhouse soil to kill fungi, bacteria, weed seeds and other organisms that may be harmful to seedling growth.

Surfactant: A compound that increases the spreading ability of a liquid (e.g., emulsifiers, soaps, wetting agents, detergents, and spreader stickers) and aids in the effectiveness of some herbicides and insecticides. Do not use any surfactants unless they are recommended by pesticide manufacturers.

Systemic pesticides: A pesticide that is absorbed by and flows through the 'system' of a plant or animal, so that the plant or animal becomes toxic to the pest to be controlled.

Top-dress: To apply fertilizer, by broadcasting, to the entire growing area after a crop is established.

Toxicity: Refers to the poisoning ability, in speed and severity, of a pesticide. The toxicity of a chemical to humans is usually based on its assumed (or known) effect on humans and its known effect on test animals.

Transplanting: The removal of plants from one growing area or growing environment to another. In vegetable crop production, some crops can be started in greenhouses and transplanted into the field, thus extending the growing season.

Weed: A plant growing where it is not wanted.

Wettable powder: Dry formulation of a pesticide that is normally mixed with water to form a sprayable suspension (e.g., Benlate 50 W).

Wetting agent: See surfactant.

Wireworm: A small 'wormlike' or 'caterpillar-like' insect that lives in the soil and is the larval stage of a beetle. These usually white, ivory or tan colored insects have hard, shiny outside coverings and can cause damage to seeds and root crops. Normal sizes range from 1 to 2.5 cm (0.25-1 in.) in length.

Variety: A botanical classification used to group or separate plants within a given species. Broccoli, cabbage and cauliflower are varieties of one species of plant. The term variety is commonly used to mean cultivar (cultivated variety).

Virus: A submicropscopic particle organism consisting of nucleic acid and protein. All plant viruses are parasitic.

Volatility: The evaporation (release of fumes) by pesticides (or any liquid or solid) after landing on the target plant. Also known as evaporation.

PUBLICATIONS AVAILABLE FROM ALBERTA AGRICULTURE

Plan No.	
6000	Fruit and Vegetable Storage (planning guide)
6110	Bulk Vegetable Storage Wall (Not Refrigerated)
6111	Bulk Vegetable Storage Wall (Refrigerated)
6112	Refrigerated Pallet Vegetable Storage Wall
6115	Bulk Vegetable Storage Interior Stud Wall
6119	Hotbed and Coldframe
M-6121	Storage Doors
6312	Bulk Potato Storage (1100 tonne, side air plenum)
6314	Bulk Potato Storage (1900 ton - Three Bins)
6315	Bulk Potato Storage (650 ton - Two Bins)
Q-6313	Bulk Potato Storage (2500 tonne, 2-bin)
M-6319	Walk-in Cooler-Freezer
6321	Small Rootcellar
6330	Fruit and Vegetable Storage Insulation
Available from:	Engineering Service, Agriculture Centre Lethbridge, Alta. T1J 4C7

Agdex No.	
Agdex 640-3	Weed Seedling Identification
Agdex 606-1	Guide to Crop Protection in Alberta, Part 1 - Chemical
Agdex 568-3	Trickle Irrigation
FS 252/20-1	Commercial Cole Crop Production
FS 258/20-2	Commercial Carrot Production in Alberta
FS 258/20-5	Commercial Onion Production in Alberta
FS 641-13	Control of Green Foxtail
FS 258/13-1	Seed Potato Production in Alberta
258/642-1	Guide to Weed Control in Potatoes
Available from:	Alberta Agriculture District Offices or the Print Media Branch, Alberta Agriculture, 7000-113 St. Edmonton T6H 5T6. Many other horticultural related publications are listed in the Publications List available from the Print Media Branch.

609-3	Herbicide Carry-Over. Cost $2.50.
Available from:	Alberta Public Affairs Bureau, Publication Services, 11510 Kingsway Avenue, Edmonton, AlbertaT5G 2Y5

METRIC CONVERSION TABLE

ACRES TO HECTARES

1 acre = 0.4 hectares
2 acres = 0.8 hectares
3 acres = 1.2 hectares
4 acres = 1.6 hectares
5 acres = 2.0 hectares
6 acres = 2.4 hectares
7 acres = 2.8 hectares
8 acres = 3.2 hectares
9 acres = 3.6 hectares
10 acres = 4.0 hectares
20 acres = 8.0 hectares
30 acres = 12.0 hectares
40 acres = 16.0 hectares
50 acres = 20.0 hectares
60 acres = 24.0 hectares
70 acres = 28.0 hectares
80 acres = 32.0 hectares
90 acres = 36.0 hectares
100 acres = 40.0 hectares

HECTARES TO ACRES

1 hectare = 2.5 acres
2 hectares = 5.0 acres
3 hectares = 7.4 acres
4 hectares = 10.0 acres
5 hectares = 12.4 acres
6 hectares = 15.0 acres
7 hectares = 17.3 acres
8 hectares = 20.0 acres
9 hectares = 22.2 acres
10 hectares = 25.0 acres
20 hectares = 50.0 acres
30 hectares = 74.0 acres
40 hectares = 100.0 acres
50 hectares = 123.5 acres

APPLICATION RATE CONVERSIONS

Metric to Imperial (Approximate)

litres per hectare x 0.09	= gallons per acre
litres per hectare x 0.36	= quarts per acre
litres per hectare x 0.71	= pints per acre
millilitres per hectare x 0.015	= fluid ounces per acre
grams per hectare x 0.015	= ounces per acre
kilograms per hectare x 0.89	= pounds per acre
tonnes per hectare x 0.45	= tons per acre

Imperial to Metric (Approximate)

gallons per acre x 11.23	= litres per hectare (L/ha)
quarts per acre x 2.8	= litres per hectare (L/ha)
pints per acre x 1.4	= litres per hectare (L/ha)
fluid ounces per acre x 70	= millilitres per hectare (ml/ha)
tons per acre x 2.24	= tonnes per hectare (t/ha)
pounds per acre x 1.12	= kilograms per hectare (kg/ha)
ounces per acre x 70	= grams per hectare (g/ha)
pounds/square inch (psi) x 6.89	= kilopascals (kPa)

°F = (°C x 9/5) + 32
°C = (°F -32) x 5/9

SEED COMPANIES

The following is a list of some seed companies commonly used by vegetable growers. This list constitutes neither an endorsement of these companies nor a suggestion that other companies do not supply vegetable seed and is only provided for the benefit of growers.

Abbott & Cobb
Box F 307
Feasterville, PA 19047

Agway Inc. Seed Division
Box 4741
Syracuse, NY 13221

Alberta Nurseries and Seeds Ltd.
Box 20
Bowden, AB TOM OKO

Asgrow Canada Ltd.
P.O. Box 610
Bradford, ON L3Z 2B2

Ball SuperiorLtd.
1155 Birchview Drive
Mississauga, ON L5H 3E1

C. Beemsterboer N.V.
Seed Growers and Merchants
Warmenhuizen, Holland

Bejo Zaden
P.O. Box 9
Dorpsstraat 612
Holland

W. Brotherton Seed Co. Inc.
P.O. Box 1136
Moses Lake, WA 98837

Crites-Moscow Growers Inc.
P.O. Box 8912
Moscow, ID 83843

Crookham Co.
Box 520
Caldwell, ID 83606

William Dam Seeds
Highway 8
West Flamboro, ON LOR 2KO

Dominion Seedhouse
Georgetown, ON L7G 4A2

Ferry-Morse Seed Co.
P.O. Box 4938
Modesto, CA 95354

Gallatin Valley Seed Co.
Box 167
Twin Falls, ID 83303

H.G. German
P.O. Box 398
Smethport, PA 16749

Harris Moran Seeds
1155 Harkins Road
Salinas, CA 93901

Herbst Brothers Seedsmen
1000 N. Main St.
Brewster, NY 10509

R.L. Holmes Seed Co.
2125 - 46th Street NW
Canton, OH 44709

Johnny's Selected Seeds
262 Foss Hill Road
Albion, ME 04918

McFayden Seeds
P.O. Box 1800, 30 - 9th Street
Brandon, MB R7A 6N4

Nickerson-Zwaan
P.O. Box 19
2990 AA Barendrecht
Holland

Northrup King Co.
P.O. Box 1827
Gilroy, CA 95020

Reed's Seeds
3334 NYS Route 215
Cortland, NY 13045

Robson Seed Farms Corp.
1 Seneca Circle
Hall, NY 14463

Rogers Seed Co.
P.O. Box 4727
Boise, ID 83711

Royal Sluis
1293 Harkins Road
Salinas, CA 93901
Seedway Inc.
P.O. Box 250, Dept. GLN
Hall, NY 14463

Siegers Seed Co.
7245 Imlay City Road
Imlay City, MI 48444

Sluis and Groot of America Inc.
124 Griffin Street
Salinas, CA 93901

Stokes Seeds Ltd.
Box 10
St. Catharines, ON L2R 6R6

Sun Seeds
2320 Technology Parkway
P.O. Box 1438
Hollister, CA 95024

American Takii Inc.
301 Natividad Road
Salinas, CA 93906

T & T Seeds Ltd.
Box 1701
Winnipeg 2, MB R3B OW3

Otis S. Twilley Seed Co.
P.O. Box F65, Dept. 210
Trevose, PA 19047

Vesey's Seeds Ltd.
York, PEI COA 1PO

Your TOLL FREE Access to Vegetable Research and Extension Staff
Alberta Agriculture

RITE stands for Regional Information Telephone Enquiry. The system is intended to provide private citizens of Alberta with a free-of-charge means of securing information from Alberta Government Departments.

To get access to the RITE system, look in your AGT telephone directory under "Government of Alberta". Every town, village and hamlet in Alberta has a separate directory listing for the Government of Alberta.

Dial the RITE number and ask the operator to connect you to the desired government office (provide number if possible).

If you live far from the toll-free RITE centre, you can phone free of charge by dialing "0" and asking the AGT operator for the toll-free number listed in your AGT directory. The call would then be connected toll-free to the closest RITE center.

Grower's Spray Record

Date Applied	Crop Treated	Stage of Growth	Field Identification	Pest Controlled	Rate Used	Remarks (Weather, Notes, Etc.)

Grower's Spray Record

Date Applied	Crop Treated	Stage of Growth	Field Identification	Pest Controlled	Rate Used	Remarks (Weather, Notes, Etc.)

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